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ABSTRACT

This document presents the transcript of a hearing held to examine how rapid technological changes are affecting the American educational system and to learn what new equipment with potential for educational application is available, how technology can be integrated into the curriculum, and how students and teachers can acquire the skills needed for a technological society. Included are statements, letters, and materials, presented or provided by John H. Gibbons (Office of Technology Assessment, U.S. Congress); Joyce Hakansson, (Hakansson Associates, Inc.); Francis Fisher (Haverford College); Linton Deck, Jr. (consultant, Fairfax County Schools); Joe Miller (Arkansas State Department of Education); Denis Eichhorn (Control Data Corp.); Reta Kohari (Apple Computer, Inc.); and John Lipkin (Bureau of Social Science Research, Inc.). Reprints of the following published reports and articles are also provided: a summary of the Office of Technology Assessment's study, "Informational Technology and Its Impact on American Education," and reprints of "PLATO System Spurs Baltimore Students to New Achievements," Anne O. Emery; "Computer and Videodisc: A New Way to Teach CPR," Lynn Hessinger; "Interactive Video Disc with Microcomputer and Manikin"; "Toward Real-World Applications"; "What the Space Invaders Are Trying to Tell Us"; "How Devices Restore Democracy"; "Interactive Training in Cardiopulmonary Resuscitation," David Hon; and "And Now, Dynamic Discs," Richard Stengel. (LMM)

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OVERSIGHT ON EDUCATIONAL TECHNOLOGY

ED239599

JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON ELEMENTARY, SECONDAR AND VOCATIONAL EDUCATION

AND THE

SUBCOMMITTEE ON SELECT EDUCATION

OF THE

COMMITTEE ON EDUCATION AND LABOR HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

SECOND SESSION

HEARING HELD IN WASHINGTON, D.C., ON SEPTEMBER 14, 1982

Printed for the use of the Committee on Education and Labor

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OVERSIGHT ON EDUCATIONAL TECHNOLOGY

TUESDAY, SEPTEMBER 14, 1982

HOUSE OF REPRESENTATIVES, SUBCOMMITTEE ON ELEMENTARY, SECONDARY, AND VOCATIONAL EDUCATION AND SUBCOMMITTEE ON SELECT EDUCATION, COMMITTEE ON EDUCATION AND LABOR,

Washington, D.C.

The subcommittees met, pursuant to call, at 9 a.m., in room 2175, Rayburn House Office Building, Hon. Mario Biaggi presiding.

Members present: Representatives Biaggi, Murphy, Kildee, Erdahl, and Petri.

Staff present: John F. Jennings, majority counsel; Nancy L. Kober, legal specialist; Tanya Rahall, staff assistant; Roseanne Tulley, administrative assistant; and Electra Beahler, minority counsel for education.

Mr. BIAGGI. The meeting is called to order.

The Subcommittee on Elementary, Secondary, and Vocational Education and the Subcommittee on Select Education are conducting a joint oversight hearing today on the issue of educational technology.

The purpose of this hearing is to examine how the rapid changes in technology are affecting our educational system. We are interested in learning what new equipment is available that has applications in the schools;, how technology can be integrated into the curriculum; and, how students and teachers can acquire the skills needed for a technological society.

This hearing is being held in conjunction with the release of the findings of a major assessment of educational technology conducted by the Office of Technology Assessment. We are pleased to welcome John H. Gibbons, the Director of OTA, to present the conclusions of this study.

We also have a knowledgeable panel of witnesses to respond to some of the issues raised by the OTA report.

We are also privileged to have with us this morning several experts in education technology who have brought along new technology being used in education today. They will be explaining this equipment after the second panel speaks and will be available for further demonstrations and questions after the hearing. We encourage everyone present to stay for these demonstrations.

Mr. ERDAHL. You and I, along with other members of the staff, are here to listen and learn some exciting new breakthroughs in this area of innovation in education. So I am just pleased to be here with you today, Mr. Chairman. Thank you very much.

Mr. BIAGGI. Thank you, Mr. Erdahl.

[The opening statement of Congressman Murphy follows:]

OPENING STATEMENT OF HON. AUSTIN J. MURPHY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF PENNSYLVANIA AND CHAIRMAN, SUBCOMMITTEE ON SELECT EDUCATION

This morning we will hear from the Office of Technology Assessment on a report which they have been working on for my subcommittee for the past 2 years which deals with one of the most discussed and controversial issues in the field of education today—education technology. Although technology has been in existence since the early 1950's, it has not been until the latter part of this decade that the introduction of the micro computer into our classrooms and homes has become so very prominent and widespread. Many questions have been raised as to the cost verses the over-all educational benefit of implementing such a system into our school settings and other training programs. I am hopeful that OTA's findings first of all be able to inform us of the types of systems being used and the extent to which they are currently being accessed, as well as comment on the social implications, if any, which have been exhibited by the introduction of the computer into the classroom. Will our teachers become obsolete? Will our students become computerized "zombies", resulting in lack of social interactions with others. Should there be some guiding role for the Federal Goverment or State government in developing a role for computerized education? All of these are questions which have and are still being asked as we enter into this "information age".

Although the development of the technology or "hardware" has been of great importance, serious attention is now being given to the development of courseware to be used by the computer in teaching. Questions have been raised as to the problems which are beginning to surface due to lack of knowledge of school administrators and faculty in selecting courseware what will do more than simply "drill" students. Also since the software/courseware is generally about three times as expensive as the purchase of the computer equipment, it will be necessary for the school district to plan their curriculum programs with future considerations in mind to insure that their software purchase today will not be obsolete within the next few years. These "gray" areas are being researched, and I hope that our other witnesses today will be able to further expound on these questions.

Technology in education is not totally new. However, we have come a long way from the use of projectors and records for our teaching apparatus. Reports by the National Institute of Education have shown that computer assisted instruction does benefit students especially in math and reading, but can technology be of value in other education programs. Hopefully we will see this today. It is important for us here in the Congress to be aware of the benefits and drawbacks to technology development and implementation into our classroom, especially in light of all the legislation which has been introduced during this Congress relating to education technology. The "information revolution" is occurring now, and not something that is a possibility for the future. It is an issue which must be addressed today, to insure the greatest return in the future.

Mr. BIAGGI. The first witness is John H. Gibbons, Director of the Office of Technology Assessment.

STATEMENT OF JOHN H. GIBBONS, DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT, ACCOMPANIED BY FRED WEINGARTEN, PROGRAM MANAGER, PRUDENCE ADLER, ASSISTANT PROJECT DIRECTOR, AND LINDA GARCIA, ANALYST

Mr. GIBBONS. Thank you, Mr. Chairman.

I am pleased to be accompanied this morning by Dr. Fred Weingarten on my left, who is our program manager for computers and information technology; Prudence Adler, who directed this project that we are reporting on this morning; and by Linda Garcia, a key analyst in that study.

We are pleased to report to you this morning about how education in the United States may be impacted by the wide-scale deployment of the new information technologies, and also, Mr. Chairman, about how some of these technologies might be used to pro-

vide and improve educational services. My remarks are derived mostly from the findings of our assessment entitled "Information Technology and Its Impact on American Education," but also, in part, from information generated in other OTA work having to do with telecommunications and microelectronics.

I would like to submit for the record, Mr. Chairman, a copy of the summary of that study that I will be reporting on, and also a one-page report brief on that.

Mr. BIAGGI. Without objection, so ordered.

[The information referred to above follows:]

Informational Technology and Its Impact on American Education

Summary

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The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or of individual members thereof.

Foreword

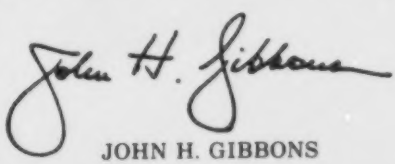
Over the last decade, American education has come to face a number of new demands that must be met with limited resources. Many of these new demands arise from the growing dependence of our society on high technology as a basis for domestic economic growth, international competitiveness, and national security. In October 1980, the House Committee on Education and Labor, its Subcommittee on Special Education, and the Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology asked OTA to examine the extent to which information technology could serve American needs for education and training.

This report documents two basic sets of conclusions:

1. The so-called *information revolution,* driven by rapid advances in communication and computer technology, is profoundly affecting American education. It is changing the nature of what needs to be learned, who needs to learn it, who will provide it, and how it will be provided and paid for.
2. Information technology can potentially improve and enrich the educational services that traditional educational institutions provide, distribute education and training into new environments such as the home and office, reach new clients such as handicapped or homebound persons, and teach job-related skills in the use of technology.

The OTA report provides an overview of the issues relating to the educational applications of the new information technologies. It examines both the demands that the information revolution will make on education and the opportunities afforded by the new information technologies to meet those demands. Rather than focusing on a single technology, it examines the full range of new information products and services such as those based on the combined capabilities of computers, telecommunications systems, and video technologies. Similarly, the report surveys a broad range of educational providers, and examines how the application of information technologies may affect their abilities to provide education and their respective educational roles.

OTA acknowledges with thanks and appreciation the advice and counsel of the panel members, contractors, other agencies of Government, and individual participants who helped bring the study to completion.



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***Served as Assistant Project Director since March 1982.

Informational Technology and Its Impact on American Education

Modern society is undergoing profound technological and social changes brought about by what has been called the information revolution. This revolution is characterized by explosive developments in electronic *information technologies* and by their integration into complex information systems that span the globe. The impacts of this revolution affect individuals, institutions, and governments—altering what they do, how they do it, and how they relate to one another.

If individuals are to thrive economically and socially in a world that will be shaped, to a large degree, by these technological developments, they must adapt through education and training. Already there is evidence of demands for new types of education and training, and of new institutions emerging to fill these demands. The historical relationship between education and Government will be affected by the role that Government plays in enabling educational institutions to respond to the changes created by these technologies.

Background

Historically, the Federal Government's interest in educational technology has been sporadic—rising as some promising new technology appeared and falling as that technology failed to achieve its promise. Attention was focused, moreover, on the technology itself and not on the broader educational environment in which it was to be used. In the late 1960's, for example, the Federal Government funded a number of research and development projects in the use of computer-assisted instruction (CAI). Interest in the projects waned, however, given the high costs of hardware and curricula and the failure to integrate computer-based teaching methods into the institutional structure of the school.

Computer-based education **is the use of computers for educational purposes. It includes:**

1. ***Computer-Managed Instruction (CMI).*** **—Wherein learning takes place *away* from the computer, while the computer scores tests, interprets results, advises the student what to do next, and manages student records and other information.**
2. ***Computer-Assisted Instruction (CAI).*** **—Wherein the student receives individualized instruction by interacting via a computer terminal with the instructional material logic stored in a computer.**

Over the last decade, Federal funding for research and development (R&D) in educational information technology has dropped precipitously. At the same time, development and applications of information technology have advanced rapidly in many sectors. Public schools, beset by problems that such technology might mitigate, have lagged behind in adapting to technological changes. In view of this situation, OTA was asked in October 1980 to reexamine the potential role of new information technology in education. The assessment was initiated at the request of: 1) the Subcommittee on Select Education of the House Committee on Education and Labor; and 2) the House Subcommittee on Science, Research, and Technology of the Committee on Science and Technology.

This report examines both the demands the information revolution will make on education and the opportunities afforded to respond to those demands. Included in its scope are a survey of the major providers of education and training, both traditional and new, and an examination of their changing roles. The full range of new information products and services rather than any single technology is examined, since the major impact on education will most likely stem from the integration of these technologies into instructional systems.

For this report OTA has defined *education* to include programs provided through a variety of institutions and in a variety of settings, including public schools; private, nonprofit institutions that operate on the elementary, secondary, and postsecondary levels; proprietary schools; training and education by industry and labor unions; instruction through the military; and services provided through libraries and museums or delivered directly to the home. *Information technology* is defined to include communication systems such as direct broadcast satellite, two-way interactive cable, low-power broadcasting, computers (including personal computers and the new hand-held computers), and television (including video disk and video tape cassette).

The assessment was premised on three initial observations and assumptions:

- The United States is undergoing an information revolution, as documented in an OTA assessment, *Computer-Based National Information Systems.*
- There is a public perception that the public schools are "in trouble," and are not responding well to the normal educational demands being placed on them. Public schools in many parts of the country are faced with severe economic problems in the form of rapidly rising costs and reduced taxpayer support. These pressures are forcing a new search for ways to improve the productivity and effectiveness of schooling.
- A host of new information technology products and services that appeared capable of fulfilling the educational promises anticipated earlier are entering the marketplace with affordably low cost and easy accessibility.

Findings

OTA found that the real situation is far more complex than assumed above. In summary, the assessment's findings are:

- The growing use of information technology throughout society is creating major new demands for education and training in the United States and is increasing the potential economic and social penalty for not responding to those demands.
- The information revolution is creating new stresses on many societal institutions, particularly those such as public schools and libraries that traditionally have borne the major responsibility for providing education and other public information services.
- Information technology is already beginning to play an important role in providing education and training in some sectors.
- Information technology holds significant promise as a mechanism for responding to the education and training needs of society, and it will likely become a major vehicle for doing so in the next few decades.
- Much remains to be learned about the educational and psychological effects of technological approaches to instruction. Not enough experience has been gained with the new information technology to determine completely how that technology can most benefit learners or to predict possible negative effects of its use. Given this insufficient experience, caution should be exercised in undertaking any major national effort, whether federally inspired or not, to introduce these new technologies into education.

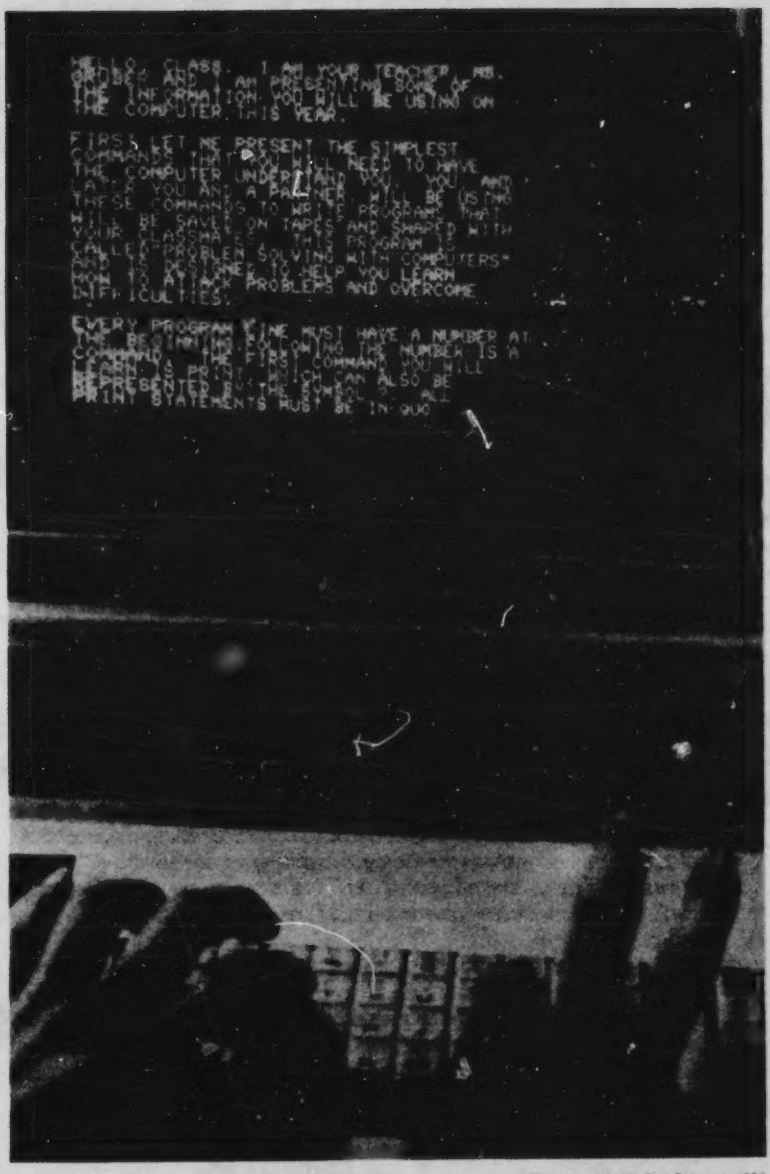
HELLO CLASS. I AM YOUR TEACHER MR.
GRUBER AND I AM PRESENTING SOME OF
THE INFORMATION YOU WILL BE USING ON
THE COMPUTER THIS YEAR.
FIRST LET ME PRESENT THE SIMPLEST
COMMANDS THAT YOU WILL NEED TO HAVE
THE COMPUTER UNDERSTAND YOU. YOU AND
A PARTNER WILL BE USING
THESE COMMANDS TO WRITE PROGRAMS THAT
WILL BE SAVED ON TAPES AND SHARED WITH
YOUR CLASSMATES. THIS PROGRAM IS
CALLED "PROBLEM SOLVING WITH COMPUTERS"
AND IS DESIGNED TO HELP YOU LEARN
HOW TO ATTACK PROBLEMS AND OVERCOME
DIFFICULTIES.
EVERY PROGRAM LINE MUST HAVE A NUMBER AT
THE BEGINNING FOLLOWING THE NUMBER IS A
COMMAND. THE FIRST COMMAND YOU WILL
LEARN IS PRINT. ALSO CAN BE
REPRESENTED BY THE SYMBOL ? ALL
PRINT STATEMENTS MUST BE IN QUO

Photo credit: © Ted Spiegel, 1982

Personal-type computers are used for instruction in many classrooms throughout the Nation

81 17

The Information Society

Role of Information

For the foreseeable future, information technology will continue to undergo revolutionary changes. The microprocessor—an inexpensive, mass-produced computer on a chip—will become ubiquitous in the home and office—not only in the easily identifiable form of the personal computer or word processor, but also as a component of numerous other products, from automobiles to washing machines and thermostats. High-speed, low-cost communication links will be available in such forms as two-way interactive cable, direct broadcast from satellites, and computer-enhanced telephone networks. New video technologies such as video disks and high-resolution television will be available. These technologies will be integrated to form new and unexpected types of information products and services, such as videotex and online information retrieval systems that can be provided over telephone or air waves directly to the home.

It is impossible to predict which of these technologies and services will succeed in the competition for consumer dollars, or which will appeal to particular markets. It is, however, reasonable to conclude that they will radically affect many aspects of the way society generates, obtains, uses, and disseminates information in work and leisure.

The growing importance of information itself drives and is driven by these rapid technological changes. Until a few decades ago, the information industry—that industry directly involved with producing and selling information and information technology—was relatively small in economic terms. It is now becoming a major component of the U.S. economy. While most economists still talk about the traditional economic sectors—extractive, manufacturing, and service—some now have begun to define and explore a fourth, the information sector. One analysis has shown that this new sector, if defined broadly, already accounts for over 60 percent of the economic activity of the United States.

Many firms involved directly with information are large and growing. Two of the largest corporations in the world, AT&T and IBM, principally manufacture information products and provide information services. Moreover, business in general is beginning to treat information as a factor of production that takes its place beside the conventional factors of land, labor, and capital. In addition, the Government is beginning to treat information as an important element of national security. While defense officials have always been concerned about the disclosure of military information—such as troop movements or weapons design—they are now also concerned about the international leakage of more general U.S. scientific and technical information that other countries could conceivably use to pursue economic or military goals that are in contrast to our own.

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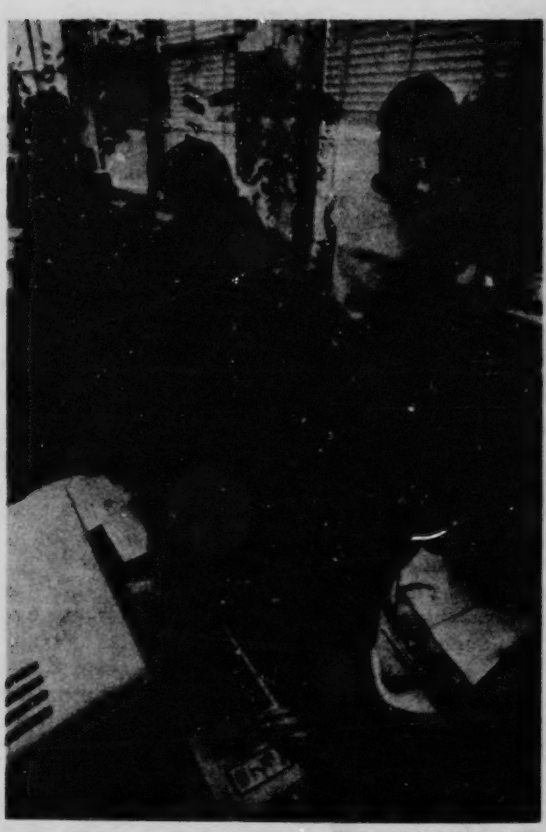

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Information technology is proving to be invaluable to people of all ages

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In addition to serving as an economic good, access to information is becoming increasingly important for individuals to function in society effectively as citizens, consumers, and participants in political processes. Relations with government at all levels are becoming more complex—whether they involve dealing with the Internal Revenue Service, applying for social benefits and services, or seeking protection from real or perceived bureaucratic abuse. Individuals are confronted with the need to evaluate more sophisticated choices and to understand their rights and responsibilities under the laws and regulations intended to protect them in the marketplace.

Information Technologies

The rapid evolution of the following technologies in the last few decades has shaped the information revolution:

Cable.—Cable systems—wherein data and programs are transmitted over a wire rather than through airwaves—are growing rapidly. The newer systems offer more channels, and some offer two-way communication.

Satellite Communication.—Satellites have stimulated development of new types of television networks to serve cable subscribers and earth station owners with specialized programing.

Digital Telephone Network.—The shift to digital transmission will allow telephone lines to carry more information at higher speed and with greater accuracy, providing better linkage of information between computer terminals.

Broadcast Technologies.—Some distribution technologies in the entertainment market may also have important potential educational uses. For one, the *direct broadcast satellite* can transmit a program directly to a home or office, bypassing a cable system. For another, *low-power stations*, which restrict transmission to a limited geographical range, provide a low entry cost to licensees and are subject to less regulation than are traditional broadcast stations.

Computers.—The design and uses of computers have advanced to the point where there is now a mass consumer market for computers and computer software. Moreover, networks that link privately owned computers have expanded access to information. *Desktop computers* are becoming more common in the home, the small business, and formal educational settings. The use of *hand-held computers*, cheaper and more portable than desktop computers, has also increased. Along with computer development have come advances in the interface between humans and computers—input/output technology. Input technology is the process of putting information into the computer—either by typing it, speaking to the computer, or showing the computer pictures. Developments in output technology, or "peripherals," are occurring in the areas of low-cost printers, graphics (particularly color graphics), and voice.

Storage Technology.—Data programs are stored on a variety of media for use in the computer: silicon chips, floppy disks, and hard disks. Improvements are being made in such technology for both large and small computers.

Video Technology.—Significant developments in several areas of video technology are likely in this decade. *Video cassette recorders* are already important consumer devices. The *filmless camera*, which combines video and computer technology to "write" a picture on a very small, reusable floppy disk, may soon be available.

Video Disks.—Resembling a phonograph record, a disk that stores television programing is of considerable interest to educators. It is durable, inexpensive to produce, and capable of storing a large amount of data and programs.

Information Services.—Several of the aforementioned information technologies are now being integrated into information systems. For example, several countries now use the existing television broadcast medium to bring information services to homes and offices. Using a *teletext* system, the user can select a page for special viewing as it is transmitted in segments over the air. In a videotex system the user can preselect a page from the central system for immediate viewing. Closely related to videotex are the *information networks* that provide owners of desktop computers and terminals with access to computer and data services and to one another over communication networks. Through *electronic conferencing*, geographically separated individuals can participate in meetings. Variations include *audio conferencing*, which uses telephone lines; *video conferencing*, which supplements the voice connection with television images; and *computer conferencing*, which involves transmitting messages through a central computer that then distributes them as requested.

Impacts on Institutions

Impacts from the information revolution are being felt by government at all levels and by the military, industry, labor unions, and nonprofit service institutions. Traditional services provided by these institutions now overlap in new ways and offer a wide variety of new services based on information technology. For example, firms as diverse as investment houses and retail stores now compete with banks by providing a variety of financial services. Banks, on the other hand, are beginning to compete with computer service bureaus in providing more general on-line information services to businesses and homes.

The U.S. Postal Service, along with Congress and a variety of Federal executive and regulatory agencies, is considering the degree to which it should compete with private telecommunications firms in the provision of electronic mail services. Large computer firms such as IBM are moving toward direct competition with traditional telecommunication common carriers such as AT&T for the provision of infor-

mation services. Telephone companies may offer "electronic yellow pages" that could rival the classified advertising business of newspapers.

Those institutions principally concerned with the collection, storage, or transfer of information will feel the greatest effects. They include both private sector firms—in fields such as publishing, entertainment, and communications—and public or nonprofit organizations such as libraries, museums, and schools. How they handle their product—information—may differ from the handling of tangible goods by other institutions because information has characteristics that differentiate it from tangible goods. For example, information can be reproduced easily and relatively inexpensively. It can be transported instantly worldwide and presumably can be transferred without affecting its original ownership. Thus, copyright or other forms of protection for intellectual property—data bases, programs, or chip designs—is important to the growth of the information industry.

While the business of selling information has always existed in some form—e.g., book publishing, newspapers, or broadcasting—the growth of this sector and its movement into electronic forms of publishing will create conflicts with traditional societal attitudes about information. The concept of information as a public good whose free exchange is basic to the functioning of society is inherent in the first amendment to the Constitution and underlies the establishment of public libraries and schools. This concept conflicts with the market view of information, which recognizes that there are inherent costs in the provision of information. Adopting new information technologies will entail extra costs that must be borne somehow by the users of those technologies.

The conflict between the view of information as a market good and the view of it as a "public good" affects public institutions in a number of ways. Public nonprofit institutions find themselves increasingly in competition with private profitmaking firms that offer the same or similar services. Institutions such as libraries, schools, and museums are beginning to feel pressure to incorporate both nonprofit and income-generating offerings in their own mix of services. To the extent that previously free or very low-cost and widely available information services such as education move into the private marketplace, access to them may become limited, either because of their cost or because of their restricted technological availability. Periodicals previously available at newsstands, for example, may be available in the future only via computer or video disk.

New Needs for Education and Training

The information revolution places new demands on individuals, changing what they must know and what skills they must have to participate fully in modern society. It may also be increasing the social

and economic prices that will be paid by those who do not adapt to technological changes. For instance, spurred by increasing domestic and international economic competition, U.S. industry is expected to adopt computer-based automation in a major way. Computer-aided design, robotics, and other new computer-based manufacturing technologies will, within the next decade, transform the way goods are manufactured. Automation will not be restricted to the factory, however. Office automation will, according to some, have an even more revolutionary effect on management and on clerical work in business. Over the longer term, even the service professions, such as law and medicine, will be transformed.

While some sociologists suggest that the effect will be to "deskill" labor by lowering the skill requirements for workers, more anticipate that a greater premium will be placed on literacy, particularly technological and information literacy. The latter argue that an increasing number of jobs will be in the information sector or will require the use of information systems. Moreover, new forms of production and information handling will create new jobs requiring new skills. Vocational education and industrial training programs will be needed to teach the skills for jobs such as robot maintenance or word processing.

An advanced information society will place a premium on skills oriented toward the creation of new knowledge and the design of new technologies. Thus, while there is some current debate about a possible surplus of college graduates, generally speaking many experts see a growing gap between the demand and supply of graduates in engineering and science, and particularly in computer engineering and science.

A key element in all of these educational needs is that they will constantly change. In a rapidly advancing technological society, it is unlikely that the skills and information base needed for initial employment will be those needed for the same job a few years later. *Lifelong retraining is expected to become the norm for many people.*

Case Studies on Information Technology

In addition to using existing information for this assessment, OTA undertook case studies designed to gain insights into the successful application of information technology in education. Accordingly, OTA examined well-established programs in public school systems, industries, libraries, museums, the military, special education, and direct to the home markets nationwide. These case studies are presented in the appendix of the full report. Many of the findings presented in this assessment reflect observations made in these studies. *The most important of these observations is that information technologies can be most effectively applied to educational tasks when they are well integrated in their institutional environments.*

Potential Technological Solutions

OTA found little evidence of current hardware limitations that would limit the applicability of technology to education and, hence, call for major research efforts. Continuing research in the general fields of computer science and engineering, coupled with innovative private sector development, will provide the necessary hardware base. The only exception is the area of technology for the handicapped, where it is not clear that the opportunities for developing specialized technology could be met without some Federal support for R&D. There does appear to be a need, however, for R&D focused on developing new techniques and tools for software development, human/machine interface, and improving the understanding of cognitive learning processes.

If properly employed, information technology has certain characteristics that suggest it will be invaluable for education. For one, information technology may be the only feasible way to supplement teaching capability in schools faced with reduced teaching staffs and larger class sizes. For another, information technology is capable of distributing education and training, both geographically and over time. Services can be provided in the home, at work, in a hospital, or in any other location where and when they may be needed.

Many of the electronic media, such as video disks or microcomputers, allow learners to use them at their convenience, instead of being locked into specifically scheduled times. Computer-based analysis, combined with a flexible, adaptive instructional system could diagnose and immediately respond to differences in learning strategies among students and, hence, could be more educationally effective. Finally, much work has been done on using information technology to improve the ability of foreign students and the physically and mentally handicapped to communicate.

Some experts suggest that the use of computers by students teaches them new ways of thinking and new ways of solving problems that may be more appropriate in an information age. They suggest that a generation that grows up with computers will have a significant intellectual advantage over one that does not. Many educators criticize such a view as being too technology-centered. At the very least one can predict, however, that computer and computer-based information services will be ubiquitous by the next century, and that learning how to use them effectively is a basic skill that will be required for many and perhaps most jobs. (In response to this view of future skill requirements, many schools have placed a high priority on computer literacy as the first instructional use of the computer.)

Although experience with educational technologies has demonstrated that they offer a variety of potential benefits, it has also demonstrated that technology cannot, by itself, provide solutions to all educational problems, nor should it be imposed on an educational system without sensitivity to institutional and societal barriers that

could prevent the realization of educational benefits. These barriers include:

Institutional Barriers.—New educational technology must be designed for ease of integration into the schools and other educational institutions that will use it. Some adaptations of curricula, schedules, and classroom organization will be needed, but the changes are not likely to be extreme.

Teacher Training.—Widespread use of technology in the classroom will require that teachers be trained both in its use and in the production of good curriculum materials. Too few teachers are *so qualified* today. Schools maintain that they are already faced with a shortage of qualified science and mathematics teachers (those most likely to lead the way in computer-based education). Furthermore, there is little evidence that most of the teacher training colleges in the United States are providing adequate instruction to new teachers in the use of information technology.

Lack of Adequate Software.—OTA found general widespread agreement that, with few exceptions, the quality of educational software—curriculum material designed for educational technology—now available was, in general, not very good. Curriculum providers do not yet use the new media to full advantage for several reasons. In the first place, many of the technologies are still new. It takes time to learn how to use them, and the early attempts suffer from this learning process. Second, production of high-quality educational software is expensive. Some large firms that have the necessary capital to produce educational software hesitate to risk developmental money in a relatively new and uncertain market.

Third, the programers and curriculum experts qualified to produce educational software are in short supply. Finally, some firms cite the lack of adequate property protection—e.g., copyright, patents—for their information products as a barrier to investment in development.

Skepticism About Long-Term Effects.—Some educators are seriously concerned that the long-term effects on learning of substituting technology for traditional teaching methods are not sufficiently understood. While acknowledging that computers or other technologies may have some limited utility in the classroom for drill and practice, or for instruction in computer literacy, they fear that any widespread adoption of technology for education could have deleterious effects on the overall quality of learning.

Cost.—Even though the cost of computer hardware and communication services is dropping, investment in educational technology still represents a substantial commitment by financially pressed schools. Costs of software are likely to remain high until a large market develops over which providers can write off developmental costs. In some cases the cost of information products and services may be passed on to users for the first time.

Policy Issues and Options

Issues

The impact of information technology on education will confront Congress with a number of important policy decisions in several areas:

- *Education and training for economic growth:* OTA found that trends in automation and the growth of the information sector of the economy will probably present the United States with severe manpower training problems over the next decade. These will include a persistent shortage of highly trained computer scientists, engineers, and other specialists; a need for retraining workers displaced by factory and office automation; and a need for a more technologically literate work force. Congress must decide what Federal response to these national needs would be both appropriate and effective.
- *Redressing inequities:* In both the OTA study on national information systems and in this assessment, OTA found concern that a significant social, economic, and political gap could develop between those who do and those who do not have access to, and the ability to use, information systems. People who cannot make effective use of information technology may find themselves unable to deal effectively with their government and to obtain and hold a job. Both social and economic concerns may motivate Congress to take action to improve literacy in American society.
- *New institutional roles:* OTA found that many public educational institutions are under severe strain, to the extent that many question their survival—at least in their current form. Actions directly related to the use of information technology could also have important impacts on these public educational institutions, both by enhancing their productivity and by helping them offer a modern, computer- and communication-based curriculum. Although the States have primary responsibility for control of the public schools, decisions and policies set at the Federal level have influenced the nature of public education and will continue to do so.

Options for Federal Action

Assuming that Congress decides there is a significant need for Federal action to address these issues, there are a number of possible actions it could take.

- **Direct Intervention.**—Congress could take action to increase and improve the use of information technology in education. Most of the following options would principally affect the schools. A few would have a broader effect on the provision of education and training in other institutions.
  —*Provide tax incentives for donations of computers and other information technology:* H.R. 5573 and S. 2281 are examples of such

initiatives. They are intended to accelerate the rate at which schools install computer hardware and to respond to possible inequities in the abilities of school districts to direct funds to equipment acquisition. However, some experts have noted that the personal computer industry is on the verge of moving to a new generation of more powerful machines that may have much greater potential for educational application on a more sophisticated level. Donations of older equipment could freeze the schools into dependency on obsolescent systems. Moreover, such incentives do not address problems such as the need for software, teacher training, or institutional barriers to effective use.

- —*Subsidize software development:* OTA found that the most-often cited barrier to current educational use of technology was the lack of adequate educational software. There may be a role for the Government in reducing the risks software producers currently see that inhibit major investment in quality courseware (educational software). Many of the existing successful packages, such as the Sesame Street programs for television and the PLATO computer-aided instruction system, were developed with partial Federal support. On the other hand, good software may be forthcoming if the producers see a sufficient quantity of hardware in the schools to provide them with a viable market.
- —*Directly fund technology acquisition by the schools:* The Federal Government could directly underwrite the acquisition of hardware and software by the schools. Such a program would create a market for educational products that would attract producers, and it would accelerate the introduction of technology into the schools. On the other hand, it may promote premature and unwise purchases of technology by schools that are unprepared to use the technology effectively. Such a program is also counter to some current trends and attitudes in Congress concerning the proper Federal role in education.
- —*Provide support activities:* The Federal Government could assume a leadership role in encouraging the educational system to make more effective use of information technology by funding demonstration projects, teacher-training programs, and the development of institutions for exchanging information about successful implementations. OTA found evidence of a high degree of interest and motivation by both schools and parents that could be more effectively channeled with appropriate Federal leadership. Such a program would not address the financial limitations that currently prevent many institutions from acquiring technology and software.

- **Adapt a General Education Policy.**—Congress is considering various forms of education-related legislation that may affect, and in turn may be affected by, the new informational needs of society. Examples are bills concerning vocational education, veterans' education, education for the handicapped, and foreign language instruc-

tion. Such legislation, if drafted with the intent to do so, could encourage the development of more effective and economical technological alternatives to current programs.

- **Support R&D.**—Federal civilian agency support of R&D in educational technology has decreased substantially over the last decade. OTA found that, to make the most effective use of technology, there was a need for R&D in learning strategies and cognitive development, methods for the production of effective and economical curricular software, and the long-term psychological and cognitive impacts of technology-based education. Congress could consider policies to: 1) directly support R&D in these areas, 2) encourage private sector investment from both foundations and industry, or 3) encourage a combination of both by using Federal funding to leverage private investment.
- **Elimination of Unintended Regulatory Barriers.**—Some legislation and regulation not specifically directed at education may create barriers to the effective application of educational technology. Telecommunication regulation, for example, can affect the cost of technology, access to communication channels, and the institutional structure of education providers.

  Moreover, protection of intellectual property, principally copyright law, was identified as a major determinant of the willingness of industry to invest in educational software. The current state of the law was seen by many industry experts as inadequate and, hence, as creating a barrier to the development of novel and innovative software. However, to the extent that such a barrier does exist, it is not clear whether its removal lies in new legislation or in the gradual development of legal precedent in the courts.

NOTE: Copies of the full report "Informational Technology and Its Impact on American Education," can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, GPO stock No. 052-003-00888-2.

General Information

Information on the operation of OTA, the nature and status of ongoing assessments, or a list of available publications may be obtained by writing or calling:

Office of Congressional and Public Communications
Office of Technology Assessment
U.S. Congress
Washington, D.C. 20510
(202) 226-2115

Publications Available

OTA Annual Report.—Details OTA's activities and summarizes reports published during the preceding year.

List of Publications.—Catalogs by subject area all of OTA's published reports with instructions on how to order them.

Press Releases.—Announces publication of reports, staff appointments, and other newsworthy activities.

OTA Brochure.—"What OTA Is, What OTA Does, How OTA Works."

Assessment Activities.—Contains brief descriptions of assessments presently under way and recently published reports.

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OTA REPORT BRIEF

September 1982

Informational Technology and Its Impact on American Education

The "information revolution" is profoundly affecting American education and training—creating new demands for instructional services and, at the same time, providing new opportunities for the improvement and delivery of such services. Whether or not new information technologies will fulfill their potential will depend, in part, on the kinds of actions that the Federal Government takes.

Explosive developments in new computer and communication technologies and their integration into complex national, and even worldwide, information systems have transformed the information industry into a major component of the U.S. economy. Many firms involved with producing and selling information and information technology are large, and rapidly growing. Moreover, business, in general, is beginning to treat information as an important economic resource and, like land, labor, and capital, as a factor of production.

This revolution is creating new demands on individuals, constantly changing what they must know and the skills that they must have to participate fully in society as both citizens and workers. Further automation and the continuing shift to an information economy will create a greater demand for, and place a greater premium on, basic literacy and an understanding of technology. Individuals will have to be continually educated and retrained. Lifelong education will become the norm.

Many of the institutions that have traditionally been responsible for educational services—public schools, libraries, and museums—may be unable or unwilling to adapt to meet these changing educational needs. Faced with a decline in the level of economic, social, and political resources at their disposal, many of them are having to curtail some of the services they provide. On the other hand, new profitmaking institutions are emerging to take advantage of the developing marke for special kinds of educational services. As educational services are increasingly provided in the marketplace, some national educational goals may not be met and some educational benefits may become less accessible to all.

The new information technologies can help all educational institutions to meet the new demands. They include direct broadcast satellites, two-way interactive cable, low-power broadcasting, personal and handheld computers, television, video disks, and video tape cassettes. Many are already being effectively used in education and training. Experience with them proves that they can be cost effective, versatile, and are capable of being used in a variety of institutional settings. They can be used to extend education to those who have previously been denied it due to age or geographical location, socioeconomic background or physical condition. They can be interactive and engaging.

Notwithstanding the potential benefits of educational technologies, OTA has identified a number of institutional barriers to their use—among them being their high initial cost, the lack of high quality programing, and the dearth of local personnel with adequate training. Experience shows that some of these barriers can be overcome if the technologies are carefully integrated into their social and institutional environments. Since public institutions may find it more difficult than profitmaking institutions to overcome these barriers, Federal action may be required to assure that the benefits of educational technologies are accessible to them.

Information technologies will be increasingly used for educational purposes. Since relatively little is known about the long-term effects on learning of substituting information technologies for more traditional teaching methods, additional research needs to be focused on this question.

Congress could take a number of specific actions to affect the development, educational application, and distribution of information technologies. For example, it might provide tax incentives for donations of computers to schools, fund teacher training programs, or support and encourage the production of high quality and economical curriculum software. But such an approach would address only a single aspect of the problem and may generate undesirable and unexpected side effects. If this is to be avoided, a broader approach, which takes into account the changing needs for education and training, considerations of equity, and changing institutional roles, will be required.

Copies of the full OTA report, "Informational Technology and Its Impact on American Education," are expected to be available from the U.S. Government Printing Office in early October. The GPO stock number is 052-003-00888-2. Copies of the report for congressional use will be available at that time by calling 4-8996. Summary copies of the report are now available at no charge from the Office of Technology Assessment.

The Office of Technology Assessment (OTA) is an analytical arm of the U.S. Congress whose basic function is to help legislators anticipate and plan for the positive and negative impacts of technological changes.
Address: OTA, U.S. Congress, Washington, D.C. 20510. Phone: 202/224-8996. John H. Gibbons, *Director*

Mr. GIBBONS. The OTA assessment was initiated nearly 2 years ago at the request of the Subcommittee on Select Education of the House Committee on Education and Labor and the House Subcommittee on Science, Research, and Technology of the Committee on Science and Technology. Since that time, several bills have been introduced in Congress that pertain either to the growing need for technological and computer literacy, or to the educational applications of information technology. The OTA assessment does not specifically address those particular legislative initiatives; rather, it is intended to provide an overview of the issues.

The report examines both the demands that the information revolution will make on education and the opportunities afforded by the new information technologies to meet those demands. It provides a review of the major providers of education and training, both traditional and new, and examines their changing roles. Rather than focusing on a single technology, the study looks at the full range of new information products and services. Some of their educational applications are being demonstrated here this morning. I must say it is a very fascinating demonstration, and I am sorry I didn't get here earlier.

To gain greater insight about the successful application of these technologies, OTA examined several case studies of their use. These case studies which provided a basis for many of the findings of our assessment are presented in the appendix of our report. Let me briefly summarize what we have learned, Mr. Chairman.

Modern society is undergoing profound technological and social changes that are driven by what has been called the information revolution. This revolution is characterized by explosive developments in electronic information technologies and by the integration of these technologies into complex global information systems. We used to think that the economic wealth and power of the world came from the plastic triad of land, labor, and capital. To that in recent years has been added the notion that energy is one of those great sources. Then later, a broader term, "technology," was added as a source of economic wealth. I think that today we should add information as perhaps one of the greatest key inputs to economic wealth and power.

In the next few decades, information technologies will continue to undergo rapid development and will be applied to an ever expanding number of activities and tasks. The microprocessor, an inexpensive, mass-produced computer on a chip, will become ubiquitous in the home, office, and industry—not only in the easily identifiable form of the personal computer, word processor, and automated production equipment, but also as a component of numerous other consumer products and services. High-speed, low-cost communication links will be available in such forms as two-way interactive cable, direct broadcast from satellites, and further evolution of computer-enhanced telecommunication services. New video technologies, such as video disks and high-resolution television, will also be available. These technologies will be integrated to form new and unexpected types of information processing, retrieval, storage products and services that can be provided over telephone or cable, or be broadcasted directly into the home.

This revolution will affect individuals, institutions, and government—altering what they do, how they do it, and how they relate one to another. Most particularly, it will probably profoundly affect those societal activities, such as education, training, and library services that are dependent upon the acquisition and distribution of information.

The growing use of information technology is already creating new demands on individuals, changing what they must know and the skills that they must have in order to participate fully in a modern society, both as citizens and as workers. Further, computerized automation and the continuing shift to an information economy are creating the greater need for, and placing a greater premium on, literacy and an understanding of technology. The kinds of skills that are needed will be constantly changing. If individuals are to thrive economically and socially in a world characterized and shaped by these developments, they will have to continually adapt through a lifelong process of education and training. The socioeconomic price of not doing so is very high.

The information revolution will also have a major impact on the educational system and on the institutions that have traditionally been responsible for providing educational services. Many public schools, libraries, and museums may be unable or unwilling to adapt to meet the changing educational needs of society. Faced with a decline in the level of economic, social and political resources at their disposal, many of them are having to curtail some of the services they now provide. On the other hand, profitmaking institutions are emerging to take advantage of the developing market for special kinds of educational services. As educational services are increasingly provided in the marketplace, some national educational goals may be compromised and some educational benefits may become less accessible to all people.

OTA found that, Mr. Chairman, that the new information technologies can potentially help all educational institutions to meet the changing needs of society. As our case studies illustrate, these technologies can be cost effective and, in many applications, are already being effectively used to provide education and training in a variety of institutional contexts.

I would like to illustrate this point with a few of the old-fashion black and white slides to the committee this morning.

Mr. Chairman, I believe we have blown a bulb.

Mr. BIAGGI. We can rely on technology, can't we?

Mr. GIBBONS. Mr. Chairman, I would be pleased to submit to you later some prints of these slides. It is a case of rapid adaptation to a changing environment. We will skip the slides this morning.

The slides indicate, Mr. Chairman, the enormously exciting environment in schools, in museums, in public libraries and in the workplace with the technology of information processing. I think it is amply illustrated by the exhibits in the room this morning, sir. We have seen it in the faces of children, and of people in their later years with equal excitement. There is a lot of interaction going on and a lot of new activities. This little microcomputer can add a great deal to the educational experience for people from all walks of life and all ages. It is "user friendly." It leads people along. It can be interactive and engaging. We have direct evidence

that it has enabled some people who are great underachievers and problem children to turn into very creative, exciting, productive students. It can be used in almost any institutional setting. And it can be used to extend education to those who have previously been denied it due to age, geographical location, socioeconomic background, or even physical condition.

The widespread application of educational technologies will most likely alter the roles that institutions play in providing education, and will blur and maybe even erase some of the boundaries that have traditionally existed between them. Today, schools, libraries, and museums are all beginning to use information technologies to provide a wide and overlapping range of educational services. And in what can be seen as a major role reversal, children, more often than not, are now educating their parents about the use of computers. I can speak as an individual witness to that point. Because information technologies are capable of providing specialized services to narrow segments of the education market, they will, moreover, make it easier to produce and to distribute education in the private marketplace.

Notwithstanding the potential benefits of educational technologies, OTA found that there are a number of barriers to their use—among them their initial cost, the lack of high-quality programing to use on them—that is the software—and the dearth of local personnel with adequate training in their use. Experience shows that some of these barriers can be overcome if the technologies are carefully integrated into their social and institutional environments. Since public institutions may find it more difficult than profitmaking institutions to overcome some of these barriers, Federal action may be required to assure that the benefits of educational technologies are accessible to them.

We are convinced that information technologies will be increasingly used for educational purposes. Since relatively little is known about the long-term effects upon learning of substituting information technologies for more traditional teaching methods, additional research needs to be focused on this question.

Whether or not the new information technologies fulfill their educational potential will depend, in part, on the kinds of actions that the Federal Government takes to assure that these technologies are used effectively and are made accessible to all users. OTA has identified several areas where it may be appropriate for the Federal Government to play an active role in its development. Anticipating structural changes in the economy and the growing need for a highly literate and technically trained work force, Congress might wish to encourage the greater use of educational technologies for manpower training and retraining. Recognizing the educational benefits that can be derived from the use of information technologies, the Congress might take steps to assure that the public has equitable access to them. Aware of the powerful nature of the technology, the Congress might take some actions to encourage their effective development and use.

Congress is presently considering a number of specific actions that would affect the development, educational application and distribution of technologies. While any one of these particular actions will affect the future use and development of educational technol-

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ogies, none of them can, by themselves, meet the total challenge that faces American education today. As the OTA report demonstrates, to meet the educational needs of an information society will involve all individuals, groups and institutions. It will require the use of a full range of educational approaches and technologies. It will, moreover, entail overcoming a wide variety of complex institutional and social barriers. And it will necessitate a thorough understanding and the continued monitoring of these rapidly unfolding technologies. I can't underscore more strongly the fact that this system is moving so rapidly that a careful monitoring of that process is essential in trying to stay up with it in terms of actions of Government.

Thus, Mr. Chairman, to foster the effective and appropriate use of educational technologies, the Congress might pay more attention to encouraging the most effective and economical technological alternatives to current programs in place now. Moreover, in areas not directly related to education, such as telecommunications, Congress could, when formulating new policy, make a greater effort to take educational factors into account when considering these other major issues. Congress might also support and/or encourage research and development in three areas. First, learning strategies and cognitive development; second, the tools and techniques for the design of effective and economical curriculum software; and third, long-term psychological and cognitive impacts of widespread use of these education technologies. These are the three areas where OTA found the greatest need for additional information.

In sum, OTA has found that the information age is having a profound effect on American education, increasing the need and the demand for a broad variety of educational services. The problem is urgent. The Nation's educational needs are not now being met, creating a situation that could impede our Nation's economic growth, undermine its international competitive position, and increase and exacerbate the socioeconomic divisions within our society. The new information technologies offer a promising mechanism and, in some cases, the only mechanisms, for responding to these educational needs. Their widespread application will significantly affect how and to whom educational services are provided. Such changes will present both challenges and opportunities for American education.

Thank you, Mr. Chairman. We appreciate the opportunity to summarize this report for you. We would be happy to try to respond to any questions you might have.

[The prepared statement of John Gibbons follows:]

PREPARED STATEMENT OF JOHN H. GIBBONS, DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS

INFORMATION TECHNOLOGY AND ITS IMPACT ON AMERICAN EDUCATION

I am pleased to be here this morning to speak to you about how education in the United States may be impacted by the widescale deployment of the new information technologies, and also about how some of these technologies might be used to provide and improve educational services. My remarks are derived from the findings of the recent OTA assessment, Information Technology and Its Impact on American Education as well as from information generated in other OTA work on telecommunications and micro-electronics.

The OTA assessment was initiated in October 1980 at the request of the Subcommittee on Select Educationof the House Committee on Education and labor and The House Subcommittee on Science, Research, and Technology of the Committee on Science and Technology. Since that time several bills have been introduced in Congress that pertain either to the growing need for technological and computer literacy, or to the educational applications of information technology. The OTA assessment does not specifically address these legislative initiatives; rather it provides an overview of the issues.

The OTA report examines both the demands that the information revolution will make on education and the opportunities afforded by the new information technologies to meet those demands. It provides a review of the major providers of education and training, both traditional and new, and an examination of their changing roles. Rather than focusing on a single technology, it looks at the full range of new information products and services. Some of their educational applications are being demonstrated here this morning.

To gain greater insight about the successful application of these technologies, OTA examined several cases of their use. These case studies, which provided a basis for many of the findings of our study, are presented in the appendix of OTA's Report. Let me briefly summarize what we have learned.

Modern society is undergoing profound technological and social changes driven by what has been called the "information revolution." This revolution is characterized by explosive developments in electronic information technologies and by their integration into complex global information systems. In the next few decades, these technologies will continue to undergo rapid development, and to be applied to an ever expanding number of activities and tasks. The microprocessor, an inexpensive, mass produced computer on a chip, will become ubiquitous in the home, office, and industry—not only in the easily identifiable form of the personal computer, word-processor, and automated production equipment, but also as a component of numerous other consumer products and services. High speed, low cost communication links will be available in such forms as two-way interactive cable, direct broadcast from satellites, and further evolution of computer-enhanced telecommunication services. New video-technologies such as video disks and high resolution television will also be available. These technologies will be integrated to form new and unexpected types of information processing retrieval, and storage products and services that can be provided over telephone or cable, or be broadcasted directly into the home.

This revolution will affect individuals, institutions, and governments—altering what they do, how they do it, and how they relate to one another. Most particularly, it will affect those societal activities, such as education, training, and library services that are dependent upon the acquisition and distribution of information.

The growing use of information technology is already creating new demands on individuals, changing what they must know and the skills they must have to participate fully in modern society both as citizens and as workers. Further, automation and the continuing shift to an information economy are creating greater need for, and placing premium on, literacy and an understanding of technology. The kinds of skills that are needed will be constantly changing. If individuals are to thrive economically and socially in a world characterized and shaped by these developments, they will have to continually adapt through education and training. The socio-economic price of not doing so is very high. Thus, for many people, lifelong education should become the norm.

The information revolution will also have a major impact on the educational system, and on the institutions that have traditionally been responsible for providing educational services. Many public schools, libraries, and museums may be unable or unwilling to adapt to meet the changing educational needs of society. Faced with a decline in the level of economic, social, and political resources at their disposal, many of them are having to curtail some of the services they provide. On the other hand, new profit making institutions are emerging to take advantage of the developing market for special kinds of educational services. As educational services are increasingly provided in the market place, some national educational goals may not be met and some educational benefits may become less accessible to all.

OTA found that, given their potential applicability to educational needs, the new information technologies can help all educational institutions to meet the changing needs of society. As the OTA case studies illustrate, these technologies can be cost-effective and, in many applications, are already being effectively used to provide education and training in a variety of institutional contexts. (slides) Witness the dimension that the microcomputer, for example, can add to the educational experience. It can be "user friendly." It can be interactive and engaging. An extremely

versatile technology, it can be used in almost any institutional setting. And it can be used to extend education to those who have previously been denied it due to age, geographical location, socio-economic background, or physical condition.

The widescale application of educational technologies will, most likely, alter the roles that institutions play in providing education, and blur the boundaries that have traditionally existed between them. Today, schools, libraries, and museums are all beginning to use information technologies to provide a wide, and overlapping, range of educational services. And in what can be seen as a major role reversal, children, more often than not, are educating their parents in the use of computers. Because information technologies are capable of providing specialized services to narrow segments of the educational market, they will, moreover, make it easier to produce and distribute education in the marketplace.

Notwithstanding the potential benefits of educational technologies, OTA has found that there are a number of barriers to their use—among them their initial cost, the lack of high quality programming to use on them, and the dearth of local personnel with adequate training in their use. Experience shows that some of these barriers can be overcome if the technologies are carefully integrated into their social and institutional environments. Since public institutions may find it more difficult than profit making institutions to overcome these barriers, Federal action may be required to assure that the benefits of educational technologies are accessible to them.

Information technologies will be increasingly used for educational purposes. Since relatively little is known about the long-term effects on learning of substituting information technologies for more traditional teaching, methods, additional research needs to be focused on this question.

Whether or not the new information technologies fulfill their educational potential will depend, in part, on the kinds of actions that the Federal Government takes to assure that these technologies are used effectively and are made accessible to all. OTA has identified several areas where it may be appropriate for the Federal Government to play an active role in its development. Anticipating structural changes in the economy and the growing need for a highly literate and technically trained work force, Congress might wish to encourage the greater use of educational technologies for manpower training and retraining. Recognizing the educational benefits that can be derived from the use of information technologies, the Congress might take steps to assure that the public has equitable access to them. Aware of the powerful nature of the technology, the Congress might take some actions to encourage their effective development and use.

Congress is presently considering a number of individual actions that would affect the development, educational application, and distribution of information technologies. While any one of these particular actions will affect the future use and development of educational technologies, none of them can, by themselves, meet the total challenge facing American education today. As the OTA Report demonstrates, to meet the educational needs of an information society will involve all individuals, groups and institutions. It will require the use of a full range of educational approaches and technologies. It will, moreover, entail overcoming a wide variety of complex institutional and social barriers. And, it will necessitate a thorough understanding and the continued monitoring of these rapidy unfolding technologies.

Thus, to foster the effective and appropriate use of educational technologies, the Congress might pay more attention to encouraging the most effective and economical technological alternatives to current programs. Moreover, in areas not directly related to education, such as telecommunications, Congress could, when formulating new policy, make a greater effort to take educational factors into account. Congress might also support and/or encourage research and development in the areas of learning strategies and cognitive development, tools and techniques for the design of effective and economical curriculum software, and long-term psychological and cognitive impacts of using educational technologies—the three areas where OTA found the greatest need for additional information.

In sum, OTA has found that the information age is having a profound effect on American education, increasing the need and the demand for a board variety of educational, increasing the need and the demand for a broad variety of educational services. The problem is urgent. The nation's educational needs are not now being met, creating a situation that could impede the nation's economic growth, undermine its international competitive position, and increase and exacerbate the socio-economic divisions within society. The new information technologies offer a promising mechanism, and in some cases the only mechanisms, for responding to these educational needs. Their widescale application will significantly affect how and to

whom educational services are provided. Such changes will present both challenges to and opportunities for American education.

Thank you Mr. Chairman. I appreciate having had the opportunity to summarize the findings in our report, and I would be happy to answer any further questions that you might have.

Mr. BIAGGI. Thank you, Mr. Gibbons.

I would like to note the presence of Mr. Murphy, who is the chairman of the Select Education Committee. His committee initiated the OTA study.

I get the impression, Mr. Gibbons, that the implementation of this technology on a broad basis would have to be a very slow and studied process; am I correct?

Mr. GIBBONS. Yes, sir. It is, in many instances, requesting a set of activities that are well founded and for some time with us, and it is a matter of the interjection of some brand new things into a system that already exists. But I believe, for that reason, one can expect to see that move more rapidly, for example, in industrial training programs, or perhaps in the Armed Forces. There are some marvelous exhibits here today of that happening.

Because the cost of this kind of technology is still rapidly dropping, and because its power is rapidly expanding, we see it as making profound inroads into our traditional centers, such as schools, museums and libraries in this decade.

Mr. BIAGGI. I understand the museums and libraries, that would be a rather static situation. It appears to me that if you are going to monitor it, as you suggested, with relation to ever-improving technology, this is going to be an extremely costly situation.

Mr. GIBBONS. Mr. Chairman, whenever one thinks of cost in this regard, it seems to me that one has to think of the cost of doing this versus the cost of what we are doing now or some alternative to it. I believe—and I might ask my colleagues to add to this—that the rapidly falling cost of this technology is now causing it to be in a new kind of era, an era in which the actual cost of acquiring and using some of this kind of technology is actually less than the way we have been doing that same kind of educational service.

Mr. BIAGGI. So it becomes cost effective.

Mr. GIBBONS. Yes, sir.

Mr. BIAGGI. You state in your testimony that the educational services being provided by the profitmaking institutions are ever increasing and, as a result, some national goals may not be met. Can you elaborate on what goals you feel may be given more emphasis and/or less emphasis by profitmaking institutions?

Mr. GIBBONS. Mr. Chairman, if I might, while I have some comments I would be pleased to make on it, I think it might be more appropriate for me to ask Ms. Adler or Dr. Weingarten if they would like to respond directly to that question.

Mr. WEINGARTEN. In our study, we didn't attempt to build a priority list of such things. But if one looks at the areas in which the technology is now being developed to serve—for instance, there is a program at the Harvard Medical School that is developing video disk applications for medical training, and there are areas of legal training, business training, and so on. Other kinds of activities, for instance, functional literacy, foreign language training—which, I believe, Mr. Simon is interested in—other areas in which there are

national priorities, do not seem now to be met. That is not a prediction one way or the other, but there is a likelihood that some of these very urgent national needs in education and training may not be the first that are addressed in the marketplace.

Mr. BIAGGI. How about the areas of disadvantaged, handicapped and other special populations?

Mr. WEINGARTEN. That is certainly another area. One way of characterizing it is whether or not the beneficiaries have the resources to purchase the education that they might need, or whether or not they constitute a large enough group to be an attractive market, people with particular kinds of handicaps, for example.

Mr. BIAGGI. Are these groups currently being reached by the present educational technology?

Mr. WEINGARTEN. We didn't find evidence of much going on in those areas. There certainly is research and development in the area of handicapped and literacy. But as the market for the technological applications develops, we see much more evidence of it developing in areas of higher profitability, those people that have the resources.

Mr. BIAGGI. It has been suggested that computers could replace jobs. Did OTA address this factor? Or can we use computers to retrain teachers so that this doesn't occur? It recalls to mind that some 30 or 40 years ago, the threat of technology hovered above the heads of the American worker, and it was supposed to have displaced all American workers. We find that that supposition by experience, has been debunked. I am just curious how you would respond to that question.

Mr. GIBBONS. Mr. Chairman, OTA is currently engaged in a project which has to do with the impacts of computerized automation in the production sector of our economy. We have completed past studies on the impacts of information technologies in some of the service sectors, such as banking and electronic message service and the like. What we see is that this kind of information technology does, in fact, displace jobs, but is also creates jobs, different kinds of jobs. That leads to an environment in which people have an opportunity, in many cases, to have a much more interesting job available to them.

This is one reason, for instance, in Japan today that the workers see computerized automation not so much as a thing that will displace their job in the factor, but will give them, rather, an opportunity to fix robots instead of tightening screws. So they see it as a mechanism for upgrading the kinds of job opportunities that may be provided to them.

There is one caveat. The workers have to train and acquire the new kinds of skills that are required for that new kind of work. But we have several projects that are completed. We have one major project underway which specifically will look at some of those issues.

Mr. BIAGGI. How about the retraining of teachers?

Mr. GIBBONS. I think some of the examples against the wall this morning in this hearing room illustrates the power of information technologies to provide very effective training and retraining to people in job skills. The fact that industry is using a lot of this now, I think, is indicative of its power. So we believe that this tech-

nology, as we said in our testimony, will not only change the nature of the workplace and the kinds of jobs that are available to people, but the very same technologies can be utilized to assist people in adapting to that change and making it a good thing, not something that is seen as a bad thing.

Mr. BIAGGI. Could you describe some of the more successful projects you have uncovered in your case studies?

Mr. GIBBONS. Yes, sir. I would like again to refer, if I might, at this time to Ms. Linda Garcia.

Ms. GARCIA. We did seven case studies in public schools, and we did some case studies in industrial applications. We look in an overall fashion at libraries and museums and applications in the home. If anything came out of those case studies, it was the need to have a very well integrated approach of getting people invnlved at the local level, getting teachers even to write their own programing and developing their own skills as teachers by learning the computer programing, and getting business groups and other groups in the community involved building networks so that the technology wasn't intimidating and was comfortable for everyone to use and become excited about.

This was especially apparent in the schools that we looked at which were most successful applications of technology.

Mr. BIAGGI. Mr. Murphy.

Mr. MURPHY. Thank you, Mr. Chairman.

Thank you, Mr. Gibbons, for coming up this morning. I am sorry I was a few minutes late, but I did review your testimony last evening.

I wondered what you might have said about the ranking of the United States in the world of education. Are there other countries that you believe or your study finds are ahead of us in providing educational techological advancements, or do you think we are the leader? Where do we stand?

Mr. GIBBONS. Let me lead off in response to that, and I will ask my colleagues to add to what I have to say, Mr. Murphy.

I believe, in the actual use of this technology, the hardware, the development of microcomputers and software packages that go with them, the United States stands second to none in the world.

Its proliferation in the marketplace—there are computer stores here in Washington. You could go out this afternoon and shop around, and shop from any one of a half a dozen different competing stores for relatively low-cost computers and a great wealth of software to go with them. Unfortunately, most of the software—not unfortunately—but, in fact, most of the software is games. There is not that much software on things that one might call a little bit more classic education. But the United States, I think, is clearly, driven by the competitive market system, it seems to me, leading with regard to developing this technology.

I won't say that we are in the lead in terms of how far we are getting along with education, with turning out engineers, computer programers, software developers or mathematicians. We frequently look to the Japanese and to the Soviets both as having instituted very impressive programs in education that we would well watch carefully and look at our own selves on that regard.

In terms of this particular technology, it is my impression that we are in the front, although there is some hot breath on our back in terms of some of the hardware that is being developed, especially in Japan.

Mr. MURPHY. I take it from that that we are the leader in the production of it and the availability of it. What about the use of it? Where do we stand in that regard?

Mr. GIBBONS. May I ask my colleagues to respond to that?

Mr. WEINGARTEN. We didn't specifically take a look at the international rankings of this sort of thing. Trying to order such a complex field as education is difficult.

On the other hand, we certainly found a great deal of concern among the experts in this country that the United States lags, particularly like science and technology education and science and technology literacy. It certainly lags behind countries that have been looked at by, for instance, the National Science Foundation. Countries like Japan, France, Germany, and the Soviet Union all seem to have much stronger programs of science and technology training. Some people estimate that the functional illiteracy level in this country is substantially higher than in any European nation, and that that may, in fact, constitute a drag on our economy and on our national development.

As far as establishing actual rankings of these things numerically, we didn't attempt that.

Mr. MURPHY. I see.

Mr. Gibbons, Mr. Biaggi alluded to the fact of replacement of personnel, which I think is not the utmost to be concerned about. But what I would wonder is whether or not we would be replacing the personal instructional touch, and how do you think technology can compete? Would we wind up having a collective type rather than a personalized approach to the classroom educational structure where the computer would be geared to all students on the same level? How do we handle that?

Mr. GIBBONS. I would not see it as the computer replacing the teacher, but rather the computer being an extension of the teacher's capability in a classroom to provide for individualized work on the part of the students and amongst small groups of students in a classroom environment. So the teacher still is the focus of the classroom environment, but has a whole new set of tools that can enable students to move at different paces and in different directions and still in the context of the classroom with the teacher.

Would you like to comment on that?

Mr. WEINGARTEN. Sure. That, in fact, was one of the concerns that we had behind our statement about long-term effects of massive wide-scale use of the technology. We really don't understand too well some of those more subtle benefits of the current education as we now practice it.

On the other hand, currently in the case studies that we looked at, the technology almost seemed to increase the social involvement of students with each other, students with teachers, and so on. We found no evidence of students going off and sitting in little cubicles by themselves.

In addition to that, there are many, currently, depersonalized educational experiences. I certainly can remember in graduate

school sitting in lecture halls filled with hundreds of people listening to a lecturer down at the bottom reading his book. We also have to be careful, I think, in each situation what we are comparing it with.

Mr. MURPHY. You are, of course, much in the same situation. We are all government, and we are concerned about what our government does. But, as you know, we do have some cutbacks in educational funding right now. We have problems in that regard.

I guess what I would like you to address is that we would seek your recommendation as to what would be the cost of the hardware, the need for training teachers in its use as a teacher aid. What are we talking about in the way of dollars? Where do we get them? How do we get it to a priority level?

Second, if we accomplish that, how do we convince the local educators that we are not foisting some Orwellian instruments on them from the Federal level and that we are mandating, and that we are interfering with the educational process? We will probably face these objections such as cost, cost of the software to the districts. Is it to be federally funded, and then do we keep the Federal Government far enough away from it to satisfy local needs?

Mr. GIBBONS. It is a very difficult question to answer, but a very legitimate question, Mr. Murphy, in part because the cost of these systems is in such rapid flux right now, even in a period of months, such as a much more sophisticated system for the same price or the same system for a much lower price. So we dealing with a rapidly moving target.

Fortunately, however, the target is dropping in terms of price. So, if anything, in the future, it appears to be less expensive than it is at present rather than the reverse in our society.

It strikes me that, in any instance of introducing this sort of thing in the classroom, it again comes back to saying how can we—at the local decision level, at the State decision level, and to the degree that the Federal Government is involved—how can we, at the maximum utility and productivity, enter an educational system for a given number of dollars? If this utility can be enhanced for the same number of dollars by beginning to incorporate some of this technology into the education and training process, then that is what ought to provide it. It should not be incorporated unless one can do more with the same resources or the same with fewer resources. That ought to always be the governing principle.

It is just that we feel we are crossing a line now very rapidly in terms of cost effectiveness, and that the trend is going to begin to be even more in that direction and, therefore, meriting a lot of attention and, as you say, all the way from the local school board to the Federal Government.

Mr. BIAGGI. Will the gentleman yield?

Mr. MURPHY. Thank you very much.

I yield back the balance of my time, Mr. Chairman.

Mr. BIAGGI. In relation to the rapidly moving technology, can you envision new generations of computers rapidly coming on line, in 5 or 10 years, and assuming that you have some educational institutions implementing this whole technology, they would be dealing with an obsolete instrument? It is foreseeable, the way the com-

puter development is going today. Every 6 months or every year, the companies are coming out with improved instruments.

Mr. GIBBONS. That is a classic concern about making capital purchases in an area where the technology is rapidly moving. It seems to me that to take that into account in making a cost-effectiveness decision, one should say, "Over how many years can my investment pay off?" If it should pay off in 2 or 3 years in terms of what I get out of it, then if it is going to be obsolete in 3 or 4 years versus 6 or 7 years, then I should still go ahead.

I think that is a decision that you and I have made, and many of us, in terms of buying, for instance, typewriters or word processors or radios or television sets.

Mr. BIAGGI. Except I remember typewriters being in school for 10 and 15 years.

Mr. GIBBONS. And there are computers that are 20 years old and still running, some of them.

Mr. BIAGGI. I am not talking about their ability to endure; I am talking about the teacher being able to teach and utilize and educate the student with the current level of technology. That is the problem. We have machine shops that are still dealing with the anvil.

Mr. GIBBONS. That is correct. And there are some jobs that have anvils, but more have numerically controlled machines. But it seems to me that if one takes that argument that we should wait until this technology has leveled out and has become a mature technology, then we will have missed the most important time for ourselves and our children to get upgraded in these skills. It is a tough decision to go at a moving target.

Mr. BIAGGI. I understand that.

Mr. GIBBONS. It has been my impression—and I will ask Dr. Weingarten to follow on this, Mr. Chairman—it has been my impression that the major breakthrough of large-scale integrated circuits and low power density machines, and the microcomputer itself, has caused now the rapidly downward breaking cost curve to begin to turn a bit now. One can see in some of the peripheral equipment, such as disks and disk drives and printers and the like, that those costs are reaching a sense of equilibrium compared to some of the other technologies involved. It is a tough question. But it seems to me, just because a computer might be replaced by an even better machine 5 years from now, it has to be kept in context that the present computer may be so enormously more advantageous in training than the equipment we are presently using in the classroom that it is worth taking a plunge.

Mr. BIAGGI. I just raised the question. I understand what you are saying, and I don't disagree.

Mr. Erdahl.

Mr. ERDAHL. Thank you very much, Mr. Chairman.

I thank you, Mr. Gibbons, and your colleagues on the panel.

As we look at this whole area, we stand on a threshold of an exciting new universe in information gathering and dissemination. It struck me last week when I was at the Children's Museum. They had an exhibit there contrasting the early computer which couldn't get through these massive doors, and a little chip the size of your

little fingernail that had the same information. We have moved ahead rapidly.

In some ways, your testimony maybe sounds a bit humorous. We think of our priorities as a society, and how the Russians, Japanese, and others seem to be utilizing their technology. I believe Mr. Gibbons said our technology was second to none, yet they utilize it to train people to fix computers, while we sell it to our kids to operate Pac Man and other video games. Maybe that is part of the freedom of our society.

The chairman asked about the use of this in the handicapped area. The question was made about profitability in computer technology. It seems to me that, if we look at this whole area of cost effectiveness—again, I serve on the Select Education Subcommittee with Chairman Murphy—we should make and stress access not only through a simple tool like the inclined plane made into a ramp for somebody in a wheelchair, but also access to the world of information and ideas.

I think that, as we look at what we have done in this area, these programs have been basically cost effective. They have been good social humanitarian investments, and I think also good economic investments, as we enable people to live independently, to become deinstitutionalized, to enter the job market and all of these things.

I am pursuaded that this new technology can be adopted for access, in the broad sense of the word, by handicapped people with various disabilities, to stress not so much their disabilities, but stress their abilities. I hope that is one thing that we would not ignore and, in fact, one thing that we would stress.

I see some heads nodding. Maybe someone could respond to that, if you wished, one of the members of the panel.

Mr. GIBBONS. Yes, sir. My colleague pointed out that perhaps I should respond. I admire your statement, Mr. Erdahl, and I would have to agree with everything you have said.

We have just completed some work on technology and the handicapped. It is for certain that this kind of information technology gives a new kind of freedom and economic opportunity for many handicapped people. It also enables one to provide services to handicapped people, to individuals isolated in one way or another, at much lower cost than, for instance, the homebound teacher and other things which would have to be personally delivered to each of these people. So we feel that it does provide a new kind of freedom for people and a new kind of economic opportunities for the handicapped.

Mr. ERDAHL. Thank you very much.

Mr. Chairman, another area would be looking at the traditional educational institutions that most of us in this committee are involved in. Let's talk about K through 12. Maybe your study touches on that. What things are being done, not only as a development of this exciting new technology, but as far as training people that end up as a classroom teacher in our teacher training colleges and universities? Do you see a good coordination in that direction and area?

Mr. GIBBONS. We see some opportunities there for improvement.

Mr. ERDAHL. That is a good way to phrase it.

Mr. GIBBONS. Let me ask Ms. Garcia to respond.

Mr. ERDAHL. Certainly.

Ms. GARCIA. If you look at the university requirements for teachers colleges, you see that very few schools—you can count them on one hand—require computer literacy of the teachers. So there is a big institutional gap between teacher training and the ability to teach children in the school. Certainly some infrastructure among teachers for computer would be needed in order to really have a wide-scale application of the technology.

A lot of schools are actually waiting to introduce computer literacy programs so that teachers are at the level of children. Most children, in terms of comfort with the technology, are above many teachers. I know that in the school where my own son took computer courses, they will not allow adults to take courses with children because the adults are so intimidated by the rapidity with which the children actually learn. I think there is an area for teacher training that needs to be taken into account before you will ever have the infrastructure to develop in schools. Our case studies show that this can be done quite rapidly when a lot of people in the community are involved together. They can be brought up and actually become the people that are serving as the resource in the community.

Mr. ERDAHL. It is interesting you bring that up, because it reminds me of a personal experience I had dealing with one of the machines at Control Data back in Minnesota. I attended a demonstration that shows where those of us who have survived some more birthdays than our teenage sons and daughters are probably intimidated by touching these machines.

One of the technicians remarked—I guess, as Members of Congress, Mr. Chairman, we have to be bold and reckless sometimes—I don't think that she was just trying to flatter me, but she said I touched the machine quicker than most people do. As adults, we are kind of intimidated by getting in there. Our kids are so used to calculators and these machines, they just wade right into it as part of their natural life.

But that might create some problems, too. If we know how to say 2 and 2 is 4 by punching a calculator and more complicated problems in a computer, do we go through the thought process of determining how that happens? Maybe this is a challenge for educators, not only to punch out the information, but to give some basis for the reason for the information and why things happen in science and in life and in psychology and a lot of other things. Maybe we get the information, but we don't go through the thought process, as some of us had to do with a pen and a pad of paper, in figuring out math and some things like that.

Is there any comment on that?

Mr. GIBBONS. I remember as a young physicist designing an electronic box to amplify some signals. I had to start with each vacuum tube and capacitor and resistor to design the box. But now, that whole function is a little unit that you can plug into a thing. So, instead of working at the highly disaggregated narrow level of designing a preamplifier, people now are able to, because that is provided them, spend that same amount of time thinking at a higher level of complexity or of aggregation.

It seems to me there is a loss. One does leave behind some of the joy of the detail. But one, at the same time, is enabled to think in broader and, in a sense, more complex ways, and that is part of the good news.

Mr. ERDAHL. Thank you very much, Mr. Chairman.

Mr. BIAGGI. Thank you.

We will now have our second panel. We have Joyce Hakansson of Hakansson Associates; Dr. Francis Fisher, professor, Haverford College; Dr. Linton Deck, Jr., consultant to superintendent, Fairfax County Schools; and Mr. Joe Miller, Migrant Student Record Transfer System, Arkansas State Department of Education, Little Rock, Ark.

STATEMENT OF JOYCE HAKANSSON, HAKANSSON ASSOCIATES, BERKELEY, CALIF.

Ms. HAKANSSON. Mr. Chairman, Mr. Murphy and Mr. Erdahl, it is kind of frightening to sit here before a congressional committee and to think that one has to, in a few moments, to, in some way, influence some things that might happen in this country. But I think that it is a very exciting time and a very opportune time to be doing that.

As you heard from the Office of Technology Assessment, and as you yourselves know, this is a time of enormous change. It has been called a time of revolution, but perhaps more clearly it is a time of opportunity. It is a time when, in fact, our actions can have tremendous influence on the future, our future and our children's future.

The opportunity in front of us right now is one that deals with the importance of information and technology and how we bring it to our society. We are, in fact, if not to be too dramatic about it, facing the opportunity to make decisions that could either enslave our society or empower us in the future.

The technology that we have in our hands today, how we treat it and how we introduce it to our children, is going to, in fact, decide whether we, as a Nation, will be able to compete in the coming years, both economically and defensively, and as an influence. As you have heard, we are ahead today, but there is a great deal of activity going on in a variety of countries around the world. There is, in fact, a lot of countries that are rapidly catching up with us.

It seems to me that in order to adequately introduce this technology to the children in our schools—and that is the area that I would like to talk about, precollege education—we really have to think about some of the traditional things that we have been doing, the ways that we have been teaching children in the past, how it will relate to the new technology, and how we can enhance our curriculum to make better use of it.

We talked a bit about the fact that what children learn will have to be changed—or should be changed, let's put it that way. In the past, we spent a lot of time on things like calculations or, as we have heard, about designing circuitry. We have taught children for a long time to be sitting at a desk and doing worksheets that are calculations over and over again so that they get precise, so that they will be able to add numbers and subtract. That kind of infor-

mation is valuable. But I think that we are going to have to look at a broader scope of education I think now we have to start looking at how we can teach children to do things like estimating and predicting and pattern recognition. If they don't use the calculators and the computers that are available to them, they will be spending much too much of their time on the nit-picking small details and not looking at the total picture.

I am sure that, at some point in the past, there was a group that met together for the preservation of the sundial. I am positive that when clocks and wristwatches first became available, there must have been a group that was around saying, "Wait a minute. We are not teaching our children to read sundials." In fact, they were correct. We were stopping to read sundials. We were becoming, if you will, dependent on technology, on the wristwatch, on the clock.

The point in fact is that we understood how the planets rotated around the Sun, and we began to understand our relationship to the world. We began to have a sense of time. I am sure if anyone tried to tell you it was 12 midnight tonight right at this moment, without looking at your watch, you could easily know that it wasn't because you have an intuitive sense of time.

So we must give our children an opportunity to develop intuitive senses of numbers, of actual information, so that they can begin to use the technology as an aid to their learning and their thinking.

Another example might be alphabetizing, another skill that we teach early to childen. It is needed. You look at a book like a dictionary or an encyclopedia, the way to get through it is A through Z. That makes sense. But when you begin to think of a large data base, and you begin to think about being able to punch in or pipe in that I want to know something about a fruit and it is a fruit that grows on a tree, you can begin to see how an apple or an orange can be the outcome of that exploration. One can come through it conceptually rather than alphabetically.

Those are just a few of the examples about how our teaching is going to have to change, how our curriculum is going to have to change, to make a merger between children and technology.

I think, also, that we have to be aware of how we are using technology in education, how we are introducing children to technology. There is, in many cases, the temptation to put the workbooks of today, the drill and practice, on a machine and have children responding, if you will, trying to get or decipher what the correct answer that the machine owns and they have to determine is. It seems to me that, by introducing that kind of education in that way, we are implying to our children that this machine has the right answer, that it owns knowledge; when, in fact, we ought to be teaching children that they are the creative managers of the process, they are the ones that ought to be doing the creative thinking, the planning, the growing, and that the machine is a tool, a resource—one of many—but a very powerful resource that can aid them as they grow and learn and decide. So the power should be in the child, in the human being, and the machine must be viewed as a tool or a resource.

It has to be done early. It has to be done the very moment the children begin to use these machines. They must be put in control.

We talk often about the machine or the computer or technology. It seems to me that it is very relevant that we understand that a computer is an empty machine without software and without programs to run in it. It is how this software is written and how it interacts with the child that decides whether, in fact, this is a personalized machine, whether it is nonjudgmental, whether it does meet all of the promise that is in a computer.

It is really vital that schools look at their software and the programs they are buying, that they are critical consumers of computer software. It is something that schools and teachers must take unto themselves. They have to evaluate it. They have to be the ones that decide whether they want it in their classrooms.

There is right now, undoubtedly, a dearth of good, acceptable computer software for use in education. I think that there has to be an understanding on the part of education and educators that this is as an important a resource as the computer hardware that they are purchasing. It is also going to outgrow very rapidly, as is the hardware. They are going to outgrow it. It is going to become obsolete.

But I think they must get into it. They must, in fact, make the decisions. They have to allocate funds for it, and they have to support a growing industry, because it will not be there without that support. It is a free industry and it should remain that way. It must have a marketplace to thrive.

I think schools must make these decisions. They have to begin to look at how they can provide very real and relevant learning opportunities for the students. If not, they are going to lose their clientele. The affluent, those who can afford to, are going to teach their children and bring these schools of technology into their own homes. They are going for alternative educational resources. They understand the power that knowledge of this technology will have for the future. We will leave our schools as babysitting institutions, and we will leave them to those who cannot make the choice.

I think that we are going to have the danger of a large gap, a power gap, between those who have and those who have not. And I believe that, by having this kind of a gap, we will lose an enormous resource of our country, and that is a number of people who have potential for creative and active participation in society. I think that goes for the disabled as well as the socioeconomically handicapped.

I don't know the role of Congress or of the National Government in this. I would like to see a great diversity of views and opinions expressed right now. This whole industry is much too young to take one direction. We don't know enough about it. We don't know enough about how children learn from it. We don't know enough about how children learn, period. We don't know about what the effect of this technology is on education or how to best integrate it into our institutions. I think we need to have a lot of different views expressed, and I think we need to have a wide diversity of views expressed. Out of that rich mix, perhaps we can find some direction that will meet the needs of our individuals within society.

Mr. BIAGGI. Thank you.

[The prepared statement of Joyce Hakansson follows:]

PREPARED STATEMENT OF JOYCE HAKANSSON, JOYCE HAKANSSON ASSOCIATES, INC., BERKELEY, CALIF.

We are in the midst of a revolution—a change from the mechanical, machine age to the age of information. Students entering our schools today and in the future will bring with them a rapidly increasing wealth of experience with computerized devices, including electronic toys, video games, and home computers. An increasing percentage of the careers open to these students when they finish their formal schooling will demand understanding of and facility with computers and similar technological devices. In order to remain relevant in or society, our educational system must keep pace with this technological revolution and prepare our youth to live and work in a technological world.

Unfortunately, not all students share equally in their access to the electronic learning experiences outside of the school environment. This disproportionate exposure to technology is often due to socio-economic factors. the non-affluent in our culture cannot provide personal computers for their children to use at home. They cannot afford the electronic toys or video games that provides middle class children early experience with technology in an inviting manner.

Often economics alone is not the barrier. It is also a lack of understanding on the part of some parents who have been excluded from the burgeoning impact of technology on business and industry. These parents may not recognize the importance of these toys and tools in preparing their children for the future. In any case, we have the potential for the development of a serious gap between the "haves" and the "have nots". Those who can afford and recognize the importance of early exposure to technology secure an advantage for their children that is not available to others. It is incumbent upon our public educational institutions to provide every student access to a minimum of experience using technology as preparation for living and working in a technological age.

Interest and motivation are not lacking. Parents, teachers, administrators, and students are eager to bring computers into the classroom. As schools re-open this fall, many of them will be integrating computers into their curriculum for the first time. Often one or more computers have come into the school due to the energy and resourcefulness of a teacher, administrator and or parent volunteer. All too often, financing was obtained for the computer hardware and nothing else. Depending upon how the computers were intended to be used, such a situation may or may not be satisfactory. If the school's sole intent is to teach programming, then a computer room with one or (preferably) more microcomputers in it, one knowledgeable teacher and a few books will do just fine. However, the limits of such an approach must be recognized. It addresses one small aspect of the machine's potential and serves only those students who are interested in computer science and able to view it as a topic of study.

In most cases schools are acquiring without fully knowing what they want to do or can do with it. Quickly they find that hardware alone is not an educational resource that will serve the variety of uses they had envisioned for computers. A viable system must include more than just a machine. This system, in my view consists of:

1. hardware powerful enough to support the broadest possible base of activities.
2. a growing library of appropriate software.
3. training and support services for teachers,
4. a budget for maintenance.

Obviously, such a system is much more expensive than the hardware alone, but all of the component parts are necessary if microcomputers are to become useful resources. When educators express frustration because they do not see the value of having computers at their school, they often have been vicitims of an "un-systematic" approach to computer planning. Perhaps the most neglected of these system components is the software. A computer is a machine that has tremendous potential for enhancing and supporting human creativity, but to fulfil its promise the machine must function in ways that humans can readily understand and apply. It is the availability of appropriate software that allows people to use the computer to solve problems or perform activities that are important to them. It is unrealistic to expect that teachers will create their own software, just as it is unrealistic to expect teachers to routinely write their own textbook.

The computer is empty by itself. It is the software, the pre-planned instructions that bring it to life. The nature and character of the machine are determined by the software. A record player is quiet until a record is placed on it, and then the sounds that it edmits are pleasant or distracting as the result of the union of the capabilities of the player with the pre-recorded notes on the record. Sounds that please, in-

spire, or arouse can all be produced by the same record player depending on which record is placed on it.

So it is with computers. They can be programmed to challenge students to think an' then allow them to use their own creativity. Or the computer can be used as a task master, forcing students to respond to questions in a narrow, pre-planned fashion. In one instance the person is the creative entity, the manager of the interaction, while the machine serves as a resource, a tool. In the second the machine is the "master", the owner of the correct answers, and the student must strive to find those answers and respond to the machine.

In a very real way, the manner in which we write our software will determine the nature of the education our children will receive and how they will perceive themselves in relation to the technological tools in their world.

The critical shortage of acceptable educational software has been often documented and discussed in educational circles, but perhaps it is not inappropriate to mention it one more time. One likely cause for the sacricity of software is the lack of economic incentives for producers and publishers to concentrate their efforts in this area. As long as schools are unrealistic in their planning, and do not allocate funds for the software necessary to turn their hardware into useable tools, they will not foster a growing and healthy educational software industry.

This industry is in its infancy. We are in a stage of exploring and learning about how to effectively use this medium and no one knows the so called right answer. Because we are exploring, it is important that as many diverse approaches as possible be explored. Out of this rich mix we should be able to accommodate a broad range of individual differences and needs.

It is apparent that society is undergoing fundamental changes, especially in the area of information, its accessibility and use. Our institutions must adapt and, when appropriate, change to best meet the needs of the individuals within society. Parents and educators are interested in the information technologies, want to learn about them, and want to understand how best to incorporate them into our educational systems. Problems arise due to the lack of understanding of the capabilities and limitations of these new intellectual aids. There are no models to follow; this is a new road and we must be flexible to learn from our experiences, our success, and our mistakes.

There are no "'right" answers to the questions we are facing, but the implications of our choices must be carefully considered and the results weighed. The role of government must be to provide the leadership needed to protect our national values while encouraging progress.

Mr. BIAGGI. Dr. Fisher.

STATEMENT OF FRANCIS FISHER, PROFESSOR, HAVERFORD COLLEGE, HAVERFORD, PA.

Mr. FISHER. Chairman Biaggi, Chairman Murphy, Congressman Erdahl, and Congressman Petri, it is an honor to be here this morning on the occasion of the release of the Office of Technology report. I look forward, as I am sure all of us do, to reading it and to studying it, and to offering comments on it when it is available.

Today, I can perhaps help the committee by making two sorts of comments addressing two issues. Why, if we have these wonderful demonstrations before us that are so effective in education and training, do we have a problem? Second, there is the question of what is the proper Federal Government's role in providing educational materials with the new technology.

It will be all too soon apparent that I am not a technologist. I am a lawyer who wandered into this field of education through public service. I would like to acknowledge publicly here the support of the Ford Foundation and the Carnegie Corp., which has permitted me to investigate these questions, and particularly the question of why don't we have more good courseware, and whether the free market alone can be expected to provide it to us.

In the summer of 1981, with their help, I was able to ask a wide group of computer manufacturers, software producers, superintendents of schools, cognitive scientists and others as to their views. I don't represent any of them this morning. I mention that to give you a sense of my background and where I am coming from. I am a convert. I believe this means of instruction is very powerful, as I think anybody who experiences it must have that feeling.

Congressman Murphy raised the question of whether it may lead us to a more regimented way of thinking. I think, quite the contrary. The power of this device is its power to interact. That permits it to become an individual instructor, much closer to the individual human tutor. Comparison isn't really fair of a human tutor and a computer. The correct question is, how does the individual tutorial of the computer compare to the classroom situation, where the vast students are rather bored by the pace of instruction and the slow students aren't understanding what is going on? The power of individualization means the computer can quickly assess where the learner is at and deliver material that is suited to that particular individual. That, I submit, is a very humane form of instruction.

One thinks of these machines as being cold, mechanistic and distant. That isn't the perception of the students. The students' perception is that they are in charge for the first time, and they are getting exactly what they want in a form that they can comprehend, and that they can be successful in learning. That is a more humane form of instruction and a very powerful one. We will see examples of that here.

We will see examples of the way in which technology integrates graphics and visual pictures with words and numbers in a way that is hard before this, and that is very powerful and engaging. Sometimes it is too engaging. While I think it is a little fun and makes learning better, it can also be a diversion. We will want to have that question in mind as we look at some of the examples.

We won't be able to see here today how this material integrates into a curriculum, into a classroom setting. I hope that those questions will be left in our minds. Do the teachers know how to use it? Is it part of a longer curriculum, or is it just one little wonderful example of what can be done?

We will see these very good examples, but I think we must bear in mind the conclusion of many observers of the scene that there is not very much good courseware out there. There is, of course, as Joyce Hakansson said, adequate courseware. I think that was her phrase.

This isn't just my view after a summer; this is the view of many others. The report of the Congressional Research Service in 1980 to the Congress, and I quote, "The most pressing and important problem of development is the creation of high-quality educational courseware."

The former Director of the Division of Science, Education and Research of the National Science Foundation, Dr. Lipson, asserted: "We find a key bottleneck is the lack of excellent course materials and software." Columbia University's Teachers College: "* * * programs currently available do not make full use of the learning potential of classroom microcomputers." The education editor of the

New York Times, in an article that I cite, complaints about the shortage of high-quality courseware.

In a study done for the National Institute of Education by the consulting firm Bolt, Beranek and Newman: "The first and, in some sense, the most obvious obstacles is the generally poor level of educational material available for the microcomputers at present * * *"

The Apple Computer Co., who is going to be demonstrating here, is now publishing a review of courseware. I think it is extraordinary that it shows also that even the manufacturer of a computer, in reviewing courseware, finds it so often wanting in quality.

Why is this? There are a number of reasons. Producing good courseware is expensive. It is more like producing a movie than like authoring a book. It demands a lot of different talents, subject matter expertise, media expertise, expertise on pedagogy, which all have to be brought together.

I found there wasn't a very good flow of information from the people who knew cognitive science to the world of educational publishers. Educational publishers are familiar with schools, but they are not very familiar with computers, and they are hard pressed financially today. They are not likely to make the long-term investment to study the theory of how you can use this technology for better education.

The greatest impediment to the production of good courseware, I believe, is an adequate basic knowledge of how the media can best be used for education. We need a strengthened body of knowledge which expands educational psychology and cognitive science to form a basis for sound programing.

I haven't read the OTA report, but on the last page of the summary document that was referred to this morning, OTA found that to make the most effective use of technology, there was a need for R. & D. in learning strategies and cognitive development, methods for the production of effective and economical curricular software, and the long-term psychological and cognitive impact of technology-based education.

That leads to the question of the Federal Government's role. Who is to do that? That is not a likely undertaking for private enterprise. Why not? Because they are going to be unable to capture the full value of what they discover. This may be a rather simplistic example, but if I do research and discover that 2 and 2 is 4, that is terribly important for society, but my company is not going to be able to get a lot of value return on the sort of investigation and research that may have lead to that truth. The truth of cognitive psychology and how we can learn from these machines will be generally terribly valuable to our society and will feed the industry of private software producers. But the generation of that knowledge is clearly a public activity, the value of which is going to go to the public good.

Let me give you an example. We will see programs, I am sure, where the computer asks the student a question, and the student answer. The student is wrong. Now, what is the best educational course of action for the computer to do next? Tell the student immediately the student is wrong? Maybe the student is having an off day and knew the answer all along. Should we wait for two wrong

answers before the tutor intervenes? How do you intervene? With what strength of intervention? Do you say, "You are wrong; the right answer is this." Do you say, "Why do you think 2 and 2 is 5? What leads you to that." In view of the nature of the drill and practice technology, that is a terribly important question: What is the optimum form of tutorial intervention?

Who is going to do the research and develop that theory and make that available to those who are going to produce? That is clearly a public activity, the value of which is going to be recaptured by the public. It is not likely to be an activity that a local school system can undertake. There may be a few State colleges of education which, with some help, might undertake some research in that direction. But I think there is an enormous area to meet this problem of quality of courseware which clearly demands a major Federal effort of research of the kind that has been laid out for you by the OTA report.

Thank you, Mr. Chairman.

May I say one more thing? The last paragraph of my testimony refers to a dollar figure of research. In reading it this morning, it seemed to me that it confused the level of research and a full program level. I think it is a confusing paragraph for the committee, and I would ask permission from the chairman to have it deleted from my prepared testimony.

Thank you.

Mr. BIAGGI. We will do that.

[The prepared statement of Francis Fisher follows:]

PREPARED STATEMENT OF FRANCIS DUMMER FISHER, HENRY R. LUCE PROFESSOR OF ETHICS AND THE PROFESSIONS, HAVERFORD COLLEGE, HAVERFORD, PA.

Chairman Perkins, Chairman Murphy, and members of the committees, it is an honor to be with you today as the Office of Technology Assessment releases its report on the effects of technology on our educational system. I look forward, as I am sure all of us do, to reading it and studying the information and policy options which the report presents. I look forward also to the occasion when it will be appropriate to provide these committees with comments on the report.

Today, I want to draw on my own experiences to help provide the committees two things:

"a context in which to view the demonstrations that will follow the testimony, that is how to recognize good courseware and whether the good courseware we see is representative of what is generally available to help educate Americans. It is my view, and that of many others, that good educational software is unacceptably scarce, and for that reason our country is missing an extraordinary educational opportunity which the new technology offers us.

"a way to assess the proper role of the federal government in the research and development effort necessary to put the new technology to good educational use. My investigations lead me to conclude that for good reasons the market will not of itself make the investment in the research and development of courseware which could provide generous returns to the nation if not to individual firms."

It will soon be apparent that my background is not that of a technologist. Indeed I am a lawyer who has entered the field of education from public service and who has only recently become concerned with the public policy issues which are presented by the use of the new technology in education.

I would like publicly to acknowledge the support that has been provided me by the Ford Foundation and the Carnegie Corporation in my review of the quality of the software used in computer-assisted instruction and in considering the issue whether we can reasonably rely exclusively on the free market to provide the good "courseware" we badly need in order to take best advantage of the new technology.

In the summer of 1981 I was thus able to discuss these questions with a wide range of knowledgeable experts: computer manufacturers, soft-ware producers, educational publishers, professors of cognitive science and school administrators. Since

then I have continued my interest in the use of the new technology in education and have assumed an advisory role with Channel 13/WNET in New York as it seeks to define just how the new technology should alter its educational function. I have also addressed the question of the impact of the computer on higher education, with special reference to the social sciences and humanities. (Fisher, (b)). Today, I am not speaking on behalf of any of those interests. They are mentioned so that you will have a better idea of my background.

I. THE POTENTIAL

Interaction-Individualization.—I am a strong believer in the potential value of the new technology for education, as I believe anyone would be who has experienced the best examples of what can be done. The new technology, unlike the much acclaimed previous technologies: radio, audio-visual aids, television, comes much closer to doing what a human teacher can do—interact with the learner. Interaction is the key to its potential effectiveness, for it permits individualized instruction. A program of computer-assisted instruction can quickly determine the level of achievement already attained by the learner and adjust the delivered material so that it meets the needs and ability of that particular student.

A natural question is how can the computer be as good as or better than a human teacher? But a fairer question is how does this individualized instruction, made possible by investment in machines and programs compare with instruction in a classroom? For as the Congress has been previously advised, the average American school child may interact with a human teacher for only one or two minutes a day. (Heuston)

As we examine the programs to be demonstrated to us following the testimony, we should be looking for how well this ability to individualize instruction is taken advantage of.

Learner control.—A corollary to individualized instruction is learner control. It is an understandable initial reaction to the idea of computer-assisted instruction that it must be mechanistic, cold, impersonal. But to the learner who may be finding for the first time that he or she can control the pace, the sequence of learning steps, the degree of repetition, indeed perhaps the very time and place at which learning takes place, the computer may seem a particularly humane form of instruction. In a classroom, too often the slow are left behind and the fast learners bored.

Graphics and visual images.—The new technology permits an intergration of pictures with numbers and words in a flexible format. This has particular value where a physical process is the subject of instruction, as anyone knows who has tried to make a repair on a piece of machinery guided only by a written manual. Increasingly, as we will be shown today, sound also can be used in an electronic interactive form.

But visual imagery (or sound) while possible is not always appropriate. It may add attractiveness but nothing necessary to the educational power of the program. While some learning is aided by being fun, some fun diverts from education. In the programs to be demonstrated, we will want to observe to what purpose these capabilities of the new technology are used.

Drill and practice, tutorial, and simultation.—Computer-assisted instruction can be used in different forms. It can drill students, reporting whether the answer proffered is correct of not, and repeating problems of the sort which the student finds difficult.

A tutorial format employs more variety of response than drill and practice programs. It reacts to student input and exploits the branching capacity of computer programming, imitating, as its name suggests, the individualized give and take of a tutorial session.

The computer can also provide an environment with little or no necessary pattern or required learning path, offering instead great opportunity for a learner to experiment. The computer program can quickly respond, informing the learner of the consequences. This rapid feedback permits a learner to exercise choices in much greater number than could be done in a real world situation. One can learn to fly an airplane, conduct a chemistry experiment, orchestrate a melody, graph algebraic equations. And quickly vary your choices after experiencing the response of the program.

Integration into a curriculum.—Courseware comes in different sizes. Some can replace the brief paragraph or diagram that a teacher might write on the blackboard. Other programs might substitute or supplement a curriculum of several years. In either case the educational value is likely to depend on how the new technology is

integrated into a large educational experience. We will want to ask of what we see today, just how that is being done.

Freedom of time and place.—While the value of computer-assisted instruction will reflect the extent to which it is part of a progression of educational experiences, those experiences need no longer necessarily take place in a particular class-room at a particular hour. This freedom of time and place should permit education more convenient for the learner. While this may enhance educational productivity it raises issues of fair distribution for those concerned with the justice of access to public education. More about that later.

II. NOT ENOUGH GOOD "COURSEWARE"?

While there are examples of excellent use of the new technology for education, there are few. I assume that we will be seeing some of them today. But the conclusion of my investigation is that there is very little courseware that fully exploits the educational potential of the new technology. Others who have reviewed existing courseware have reached the same conclusion.

The Report of the Congreessional Research Service for the Subcommittee on Science, Research and Technology of the Committee on Science and Technolgy entitled "Information Technology in Education: Perspectives and Potentials," issued December 1980, concluded:

"The most pressing and important problem of development is the creation of high-quality educational courseware" p. 3

The former Director of the Division of Science, Education and Research of the National Science Foundation, Dr. Joseph Lipson, has asserted:

"We find a key bottleneck is the lack of excellent course materials and software. Almost every expert and relevant government official whom we have contacted makes this observation" (Lipson p. 34)

Education Week, March 31, 1982, reports a study by Vicki L. Blum, a researcher at Columbia University's Teachers College concluding that "programs currently available do not make full use of the learning potential of classroom microcomputers and that programs of questionable educational value flood the market." (Education Week)

In an article entitled "Computer Software Found Weak", Fred M. Hechinger, the education editor of The New York Times reports the Cohen study and another by Karen Sheingold, of the Bank Street College of Education in New York, which also complained about the shortage of high-quality software and the general failure to integrate computer-based instruction into the overall curriculum. (New York Times, April 20, 1982)

In a report "Microcomputers in Education", prepared for the National Institute of Education, Feurzeig, Horwitz and Nickerson of the consulting firm Bolt, Beranek and Newman listed problem areas that posed "obstacles to achieving the full potential of computer-assisted education". The report states:

"The first, and in some sense most obvious, of these obstacles is the generally poor levels of educational material available for microcomputers at present . . . The development of such software is essential before the educational opportunity represented by declining costs of hardware can be fully realized. (Feurzeig, Horwitz and Nickerson, p. 98)

I also refer the Committees to the two excellent issues of a review of micro-computer software now appearing under the name The Apple Journal of Courseware Review. One is struck that even those with an interest in promoting the sales of computer hardware report that educational software is not what it should be. (Apple Journal of Courseware Review)

I will be surprised if the OTA study does not reach the same conclusion as to the inadequate supply of good courseware. Indeed, there is no longer a need to study that problem; there is a need to do something about it.

III. REASONS FOR SHORTCOMINGS OF EDUCATIONAL SOFTWARE

There are a number of reasons why better software is not being produced. In part, the development of good software is expensive. It is more like producing a movie than publishing a book, involving a number of quite different skills: computer programming, subject matter expertise, knowledge of curriculum-relevant pedagogical skills (how do we really learn to spell) and a new knowledge of ways of exploiting the new media.

I found in my investigation that there was not a good flow of information from the academic community which knows about cognitive science to the world of educational publishers. Educational publishers, while familiar with schools are not famil-

iar with computers, and are hard pressed financially, not looking for long-range large research for investment. The new cottage industry of educational programmers are innovative, but unlikely to be knowledgeable about the theory and practice of learning nor are they well financed. Their products are typically small programs, rather than large pieces of a curriculum. (Fischer, ref A)

But the greatest impediment to the production of good courseware, I believe, is an inadequate basic knowledge of how the media can best be used for education. We need a strengthened body of knowledge which expands educational psychology and cognitive science to form a basis for sound programming. In brief, we need to know better how we learn, and we need to know that with particularity, for the new technology demands particular design, whether in a courseware program or the design of an electronic environment in which learning can take place. Indeed this demand for more precise knowledge of the learning process is helpful in driving the necessary research.

I should point out also that research in education demands extensive and long term field tests and evaluation. We may note obvious shortcomings in courseware and be attracted to what we believe are good programs, but the ultimate test of educational effectiveness is whether it actually instructs. For such evidence we need long term evaluation and controlled experiments.

This research and development effort needed is a large order, but we know the fruitful paths to pursue. Indeed the efforts of the National Institute of Education and the Science Education and Research Division of the National Science Foundation were supporting exactly the kind of work needed. Unfortunately, these efforts have been cut back or suspended.

IV. ROLE OF THE FEDERAL GOVERNMENT

Why is the federal government necessarily involved? It was the purpose of the investigation I conducted for the Ford Foundation to see whether we could reasonably expect the necessary development investment to be undertaken by private enterprise. It was my conclusion that this was not a job which we could expect the free market alone to accomplish. This is in part for the reasons already referred to, the large amounts involved, the long time required for obtaining a return on investment, the lack today of enterprises which combine the necessary expertise involved.

But more fundamentally, it is because the return on the investment will run largely to society in general and cannot be captured by an individual commercial enterprise. It is somewhat like investing in the development of arithmetic and concluding on the basis of research that $2+2=4$. The discovery of principles of cognitive science and educational psychology and linking them to the use of the new technology is valuable, but the value mostly accrues to society as a whole.

Particular developers of courseware may be able to protect to some degree their specific newly developed computer programs through copyright or technical procedures that make copying difficult, but the big truths about how we learn, more specifically how we learn with the new electronic media, will not be, nor should they be, private property. But because that knowledge is a public good, a valuable public good, it will only be the public that can obtain a return on the necessary investment in research and development. Either the public accepts the opportunity of seeking the knowledge on which good courseware must be based or that knowledge will not be produced in the quality and quantity which the promised social returns fully warrant.

It will be interesting to see the extent to which the good demonstrations we are about to see were supported in their development by government funds, or depended on work which was in turn so supported.

I will not repeat here the importance of improving our education. The members of these committees are fully cognizant of how our economic productivity, national security and human fulfillment depend on good education. But what I want to emphasize is that the particular improvement that this new technology offers will not be realized without government action. One can concur, as I do, with the policy that government should not act where others will and still conclude that the research and development which must proceed the production of compelling examples of good computer courseware must be supported by government.

And I would suggest that while the delivery of education and the ultimate choice of curriculum is appropriately a matter for local school districts, those institutions of government are not best suited for promoting a program of research and development.

Mr. Chairman, members of the committee, I recommend (1) that the OTA report be promptly sent to the Department of Education and the National Science Founda-

tion, and that both be requested promptly to inform the committees of their comments and suggestions and to report on what they are currently doing and propose to do in fulfilling the federal role so that this country will exploit fully and advantageously the new technology.

(2) That a series of hearings be scheduled now at which the committees can be more fully informed by the concerned sectors of our society as to their reactions first to the OTA study, after having had a time to study it, and the responses of the Department of Education and NSF to the questions listed above.

In June of this year I was privileged to attend a conference on research in computer-based education, arranged by Fred Hofstetter of the University of Delaware, who is with us today. I came away awed by the developments in computer-based technology, as I am sure we will be awed by what we see here today. From what was reported there it seemed to me clear that in a not distant time, 10 years or 15 perhaps, we would have electronic machines that for practical purposes could do anything you wanted. The problem is that we do not know what we want them to do. I very much believe that if we bent every effort to explore that question, we will not be ready fully to avail ourselves of the increased power that is coming our way, as we are not using the power that is currently available to us.

I do not know the appropriate size of the effort we should be making. A research and development effort in electronic courseware of $100 million a year would not restore us to the level of productive effort we were recently making, so it is a safe starting point. The exact magnitude and kind of effort beyond that should be quickly settled. I trust the OTA report will help us do exactly that.

Thank you.

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Mr. BIAGGI. Dr. Deck.

STATEMENT OF LINTON DECK, JR., CONSULTANT TO SUPERINTENDENT, FAIRFAX COUNTY SCHOOLS, FAIRFAX, VA.

Dr. DECK. Good morning, Mr. Chairman.

I am Linton Deck. For the past dozen years, I have been the superintendent of schools in three large school systems in Georgia, Florida, and, most lately, in Fairfax County, Va. During this current academic year, I will be a senior associate for the advanced study at Vanderbilt University, where I will be taking a hard look at a number of issues about which we are talking this morning.

I am very pleased to have the opportunity to speak to you this morning and to make some direct recommendations on the basis of

a number of comments which have already been made. I would like to indicate that Chairman Murphy's letter of invitation to appear here this morning asked that I speak to eight areas. In my written material, I have attempted to do that. I am going to summarize that very quickly, if I can.

Let me start by saying that in the State of Florida in 1979, I chaired a commissioners task force to look at a number of these issues. When we made our report to the legislature of that State and to the Commissioner of Education of Florida, we summarized our efforts by saying that we believe Florida could not afford not to invest in this technology for use in schools in the State. I want to paraphrase that this morning and say that I am convinced that the United States cannot afford not to invest immediately in this technology for use in the schools throughout the Nation. There are a number of ways to do that, and I tried to make comments about those in the written material which I have submitted.

Dr. Fisher's comments about the development of the quality of software right now lead me to make a recommendation about a strategy for how I believe that can be done. I believe that the development of public/private consortia for such development is a very promising strategy. During the past 10 months, I have been personally involved in an effort to establish a consortium of several school systems, a publishing corporation and a university. While we have not yet brought those efforts to closure, the experiences we have had in this effort lead me to believe that it is a truly promising option for the development of quality instruction material and courseware, and the need for quality software national attention and national action, in my view.

I am going to recommend in a moment a plan which would nurture the development of consortia of that sort to help in this problem.

I think everybody understands that training and the levels of understanding which teachers and educational managers have in our schools represent a big need. It is very clear that teachers, however, in my experience and in my view, would respond to sound training, and would and could utilize intelligently the machines that are available and as quality software can be made available to them. But training is a very widespread problem.

In a very recent survey of more than 130 teachers education institutions in the southeastern United States, it was indicated that less than half of them offer any kind of in-service training on microcomputers for the education faculty in those institutions. David Moursund, a scholar in this area, a professor of computer science at the University of Oregon, estimates that as few as 5 percent of the more than 1,350 teacher-training institutions in the country offer undergraduate courses in computer education, and a very small fraction of these include such courses in their degree requirements. So the need for training is very clear and obvious.

I want to make one argument, though, to say that that training should include not only teachers, but educational managers.

With that caveat, let me turn to the specific proposal I would like to make as a basis for your deliberation and consideration.

I believe that there are three areas of focus of the funding problems related to the use of computers in the schools that deserve na-

tional attention. The first is the cost of computers themselves; second, the cost related to the development of the quality courseware, which Dr. Fisher has alluded to; and third, the training needs which exist in the schools. I want to emphasize that both classroom practitioners and educational managers need support and assistance in learning how to utilize the potential represented in the application of computers in our schools.

Educational managers need help in thinking through the issues of how to develop new budgeting philosophies and techniques so as to find ways to make it possible to put computers in the schools and provide the programs that are necessary to work with private sector personnel and university personnel.

I want to emphasize in the very strongest way that focusing on the training needs of teachers without giving attention to the needs of educational managers to learn how to help teachers get the job done would be shortsighted at least, and wasteful at worst.

Support systems for intelligent use of computers in the schools cannot be built nor maintained unless principals, superintendents or other educational managers have the opportunity to become literate in regard to these machines and develop the understanding necessary to oversee and facilitate appropriate program development.

I could also develop, and hope that I have in the root material, a very strong case for the training needed by teachers. So I want to recommend to you for your consideration action which I believe is badly needed, action in the form of a 5-year implementation program involving components of training, software development and software acquisition.

One way to begin this action would be to focus on secondary math and science teachers. That is just one way, but it is a good one. In my judgment, an action of this sort ought to focus on providing training for approximately 33,000 math and science teachers each year over the next 5 years, and 2,000 other educational practitioners, principals, curriculum coordinators, and other educational managers. I believe this could be done in a sound way using what I call an NDEA, National Defense Education Act, training model, at a cost of about $10 million a year for the next 5 years—that is, $300 times 35,000 teachers and educational managers. I believe that would be a reasonable way to begin.

An estimate for the current investment in the development of courseware would be about $10 million. I believe that congressional action ought to double the present investment for the next 5 years, that is to allocate $10 million per year for software development. That matches what is being done in the private sector, and I believe that matching arrangement ought to be done so as to nurture the establishment of consortia of the sort that I mentioned a few minutes ago.

The schools must acquire this software as it is developed, through consortium arrangements or whatever. So I urge that you consider appropriations for software purchase. I suggest an investment of about $20 per student. This would amount to $50 million per year for the next 5 years.

So, in summary, I recommend a program of action to focus on improving math and science education through the use of computer

technology over the next 5 years involving components of educational practitioner training, software development in public/private consortia, and software acquisition in the schools. The total cost would be $350 million over the next 5 years, or $70 million per year. I believe that set-aside appropriations for research and development on the issues and problems involved in the adaptation of computer technology in the schools should amount to 10 percent of that, or $7 million per year.

I believe that any program of action that you undertake should include review of public policy and law as well as funding. It has been pointed out earlier this morning that attention needs to be given so as to facilitate the development of courseware about which we have been talking here and to enhance the feasibility of computers being made available through the vehicle of legislation which has already been introduced in the Congress.

I urge all of you and your associates in these two subcommittees to do everything possible to implement a program of action such as has been suggested here.

I thank you for the opportunity to make these suggestions on behalf of the young men and women who make up the student bodies of the schools throughout the United States. Thank you, Mr. Chairman.

Mr. BIAGGI. Thank you.

[The prepared statement of Linton Deck follows:]

PREPARED STATEMENT OF LINTON DECK, CONSULTANT TO SUPERINTENDENT, FAIRFAX COUNTY SCHOOLS, FAIRFAX, VA.

I. INTRODUCTION

How pleased I am to have the opportunity to present these comments to the hearing of the House Subcommittees on Select Education and Elementary, Secondary and Vocational Education.

My name is Linton Deck. During the past dozen years, I have been Superintendent of schools in three large school systems in Georgia, Florida, and Virginia. Most recently, I have served as Superintendent of the Fairfax County Public Schools in Fairfax, Virginia, which is the tenth largest school district in the United States. During this 1982-83 academic year, I will be a Senior Associate for Advanced Study at Vanderbilt University in Nashville, Tennessee. This assignment will provide opportunities for post-doctoral study of many of the issues addressed in this presentation. For the past several years I have been increasingly interested and concerned about the implications of computer technology for the public schools of the United States. In 1979, I chaired a task force appointed by the Commissioner of Education in the State of Florida to study the implications and impact of computer technology in the schools of that state. During the past two years I have been a member of the Advisory Committee on Technology in Education of the Office of Technology Assessment.

The letter of invitation which I received from Chairman Murphy and Chairman Perkins requested that I address the need and increasing demand for computer technology and program software, the problems incurred not only in financing such systems, but those arising from parent and teacher objections to implementing such systems, as well as the effects which this technology is and will continue to have, good or bad, on not only our children, but on our society as a whole. That is a very sizeable assignment, and I hope that this document responds in some useful way. In response to the request of the Chairmen, this presentation is organized in nine sections:

I. Introduction.—(Page 1).
II. Need for hardware.—(Page 6).
III. Need for software.—(Page 8).
IV. Funding problems.—(Page 11).
V. Parent objections.—(Page 14).

VI. Teacher objections.—(Page 16).
VII. Effects on children.—(Page 19).
VIII. Effects on society.—(Page 22).
IX. Proposal for action.—(Page 28).

As a part of the preparation of this document, I asked several of my colleagues—teachers, principals, and others—to help me by providing statements of their views and opinions about the impact of computer technology in the schools. I believe it appropriate to quote what one elementary principal wrote. He is Dr. Richard Lavine who is principal of an elementary school in Fairfax County, Virginia. In a memorandum to me written just a few days ago, he stated:

"In light of the pressing need to prepare our students for the 21st century, I am dismayed by opposition to computer utilization within our profession and outside. The information age is upon us and yet some of us are hanging by our fingertips to an outmoded set of beliefs.

"For public education to serve the needs of today's children and to avoid creating a generation of disenfranchised, easily manipulated adults, we need to assure that the schools are more technologically relevant.

"The computer and the age it foreshadows also has the potential for beauty and ugliness. Education must ensure that enlightened, educated users create an age of beauty."

A math teacher who is currently responsible for efforts to use computer technology in a large school system in the southeastern United States sent me a memo last week. I would like to quote a portion of what he wrote:

"I am now in my 12th year to trying to develop and maintain at various levels a computer science, and now a computer literacy, program in a large school system.

"For years I went through a very frustrating experience of trying to do this without the proper resources, and without support from our school system organization. We survived mainly on the basis of a grass roots effort. It was happening because the teachers that became trained in doing this wanted it to happen and the students and the community wanted it to happen.

"Not quite three years age, we had the good fortune to get a top administrator in our school system who had the same ideas and the same concerns about the need for implementing technology within a school system. The community was very supportive of this, and principals and teacher were overjoyed. So we have had a period of two years of acquiring the resources that we never have, getting staff for technology, and getting hardware and all the various components that are needed.

"Teacher training is, of course, very critical to this whole effort. We are building a program with the resources to train our staff and our teachers. This takes a cooperation from industry that has never really existed with school systems at this level of commitment.

"As I now work in my job and hear the community coming at me, PTA presidents, and principals, and other administrators throughout the system asking for and expecting the delivery of resources, the delivery of courses to train teachers, I realize we have undertaken a gigantic job.

"We need more people in the U.S. willing to make decisions favoring the resources that are needed, and we need to continually try to get those resources. If we do not do this, I worry about what will happen with the children in our school system right now who would not be provided with this education, or worse, I worry about teachers suddely realizing that they are becoming more and more useless to the students as the technology evolves and as the students themselves gain experiences that the teachers can't identify with, or can't share with them. The alternative to doing nothing is really no alternative. We must make the kinds of commitments that need to be made."

My experiences over the past several years reinforce the viewpoints presented by both Principal Lavine and my math teacher friend. Because I know that many other principals and teachers feel the same way, I believe this is the time for direct action by the Congress, the United States Department of Education, the various state legislatures, state departments of education, local school boards, and the management teams of local school systems to take action for the intelligent adaptation of computer technology in the schools of the United States.

I believe that this technology will come to play a central role in the public schools of America. History suggests that such a phenomenon does occur when (1) a technology first gains cultural acceptance (i.e., admittance to a large number of homes) and (2) the technology becomes a primary work tool. The first factor reduces opposition to the introduction of a particular technology into the schools, and certainly this phenomenon is clearly recognizable in the United States today. The second factor generates public demand that the schools adopt the technology and provide training

in its use. Evidence of this second criterion is growing all across the country. It appears computers will have sufficient hold on the society of the United States by 1985 for proper training in their use to replace basic skills as the primary public concern in education. Moreover, the increasingly critical relationship between technology and economic development will make the outcry to access to training in computer technology particularly aggressive. I believe that the schools of the United States have responsibility to respond to these conditions with the help of the peoples' representatives in the Congress, the state legislatures, and local school boards.

II. NEED FOR HARDWARE

In early January, 1980, the Commissioner's Advisory Committee on Instructional Computing in the State of Florida delivered a report to the Commissioner of Education of that state. One of the ways to underscore the critical need for investment in computer hardware for the schools of America is to paraphrase that report.

The Advisory Committee reached concensus on a group of assumptions which could serve as a basis for public policy in the State of Florida. The assumptions were the product of a review of pertinent literature, exchange between members of the Committee and nationally recognized expert consultants, and deliberation by the Committee and the staff persons who supported the Committee's activities over a period of six months. Two of the assumptions emphasized the need for computer hardware in Florida's schools, and they also apply to the national scene:

(1) Computer technology will play an increasingly pervasive and dominant role in American society during the next generation. Thus, the United States cannot afford not to invest immediately in this technology for the schools of the nation.

(2) The economic development of the United States demands public investment in computer technology to prepare citizens for new employment and up-grade the skills of those already employed.

Additional perspectives which support these assumptions will be provided in the later section in this document which deals with the effects of computer technology on society.

However, it is important here to emphasize that investment in computer hardware in the schools in the United States is going to have to be done in the context of economic change which have overwhelmed and outmoded traditional approaches to management in education as surely as they have done in the private sector. New philosophies of and techniques for budgeting, fiscal management, classroom management, and teacher preparation must be implemented. This means that some form of investment must be made in training and renewal activities for the educational managers of the school system and universities of the country. Additional comments about this will be made in a later section dealing with funding problems.

The need for computer hardware in American schools can be summed up in a restatement of the first assumption of the Florida advisory group: The United States cannot affort not to invest immediately in this technology for use in the schools of the nation.

III. NEED FOR SOFTWARE

There is a general consensus among teachers and other educators, publishers, computer manufacturers, and other interested parties that there now exists a paucity of software or courseware of excellent quality. Educational software is commercially available in a wide array of formats and subject matter and some of it is of good quality, but much of it deserves the criticism it gets. Some criticism is based on such trivial concerns as programs having spelling errors or typos or having inappropriate formats. More serious kinds of criticisms relate to programs having bugs which prevent them from working under certain circumstances; even more serious concerns relate to programs unusable by students because of unclear instructions or having important steps omitted. There are some concerns which focus on very important issues including the fact that much of the commercially available software employs limited and limiting "drill and practice" and "tutorial" approaches; neither of these approaches taps the real potential of the computer because they do not represent a departure from the most traditional kinds of pedagogical methods.

There are many reasons for this situation, of course. Some of the reasons are as obvious as the fact that the developmental explosion of microcomputers presents a situation far ahead of the development of programs enabling schools or other agencies to make good use of the power potential of the machines. A less obvious reason has to do with the fact that many publishers apparently find themselves wrestling with extremely tough issues related to the relatively high cost of production of courseware, and the impact of current copyright laws and other public policy on

this kind of development. It is difficult to realize a profit from materials which can be so easily copied in the market without fair return to the developer and publisher. The development of quality software takes a great deal of time—probably more time than the development of a textbook. All of these variables contribute to the current situation, and there is no indication that this dilema will be resolved in the immediate future.

Programs are beginning to emerge in an area where quality software is particularly important, in my view. Many computer companies and publishing organizations are providing increasingly better materials for the development of so-called "computer literacy." In these programs the computer itself the object of study, and this is desirable. However, some of the same criticism which apply to the general array of educational software also apply to some computer literacy programs.

Successful adaptation and utilization of computers in the schools will depend upon the development of instructional approaches for which the computer is uniquely suited, or for activities which could not be done effectively without the computer. Such software would go far beyond drill and practice and tutorials. Elaborate simulations, demonstrations, programs which provide for extensive testing of hypotheses and the manipulation of many variables, text editing of all sorts, complex educational games, and responsive computer languages are all approaches which meet the requirements of being uniquely suited for the computers or not feasible without using such machines. Such programs are much more difficult and time-consuming to produce and as a result they are relatively rare. In my experience, which seems to be matched by some other observers, such development often takes place in the schools where individual teachers get excited about the potential of computers and develop good programs on their own. This is not to say that all teacher-developed programs are good, but a number of high quality programs have been developed in this way. Other development takes place in universities for use as a part of the instructional program of those institutions. Publishers are beginning to seek out these true innovators in computer curriculum and nurture what they are developing. I believe that this kind of effort should be enlarged so that publishers provide time, money, and publishing and marketing expertise for these approaches to education which are truly revolutionary. Educators must resist the mediocre software currently being marketed, and demand the development of quality materials.

The development of public/private consortia for such development is a most promising strategy. I have been personally involved for several months in an effort to establish a consortium of a publishing corporation, a number of public school systems, and university. The experiences we have had in this effort lead me to believe that it is truly a promising option for the development of quality instructional materials and courseware. The need for quality software deserves national attention and action.

IV. FUNDING PROBLEMS

Investments in the schools of the United States in order to successfully adapt computer technology in American classrooms will serve to enhance economic development in the nation, as well. The schools have been, and will continue to be, contributors to the economy of the country because they provide a literate and trained workforce and enlightened citizens who are economic consumers. The most basic needs for funding related to computer technology in the schools are in three areas of investment:

(1) Funding for hardware, that is, the computer machines needed in the schools.

(2) Funding for software, that is, the development and marketing of programs which have the requisite quality to be well used in the classrooms of the nation.

(3) Funding for training and renewal of classroom practitioners and educational managers.

Most researchers who have reflected on problems of funding hardware, software, and training in relation to the use of computer technology in the schools remind us of the fiscal nature of the educational enterprise. It is labor-intensive, and thus the possible areas for reallocation of resources to buy hardware, develop software, and train personnel are quite limited. The average school system in the United States spends approximately 85 percent of its budget on personnel. Of the remaining 15 percent, the majority of expenditures do not purchase instructional equipment (computers), program development (software), or staff development (training for personnel).

Obviously, this situation calls for new philosophies and techniques for budgeting and fiscal management as has been pointed out in an earlier section each student would have access to equipment for 30 minutes, then the equipment cost per stu-

dent per year would vary between $17 at the lower end and $30 at the upper limit. If one assumes a courseware cost ranging between one-third and one-half of the equipment cost, then the student cost per year would vary between $23 at the lower end and $45 at the upper. In communities which spend about $2,300 per year per student (if they do not now, they soon will) the cost of 30 minutes per day of computer-based individualized instruction ranges between one percent and two percent of total instructional cost per student. And this cost can be reasonably expected to decline over the next several years! Details about these costs are available from the United States Department of Education.

In the final section of this presentation, I will recommend a proposal for Congressional action which will focus on courseware development and the training required in the schools of the nation. I believe that courseware development can best be done in the context of cooperative arrangements between school system, publishers or other private sector organizations, and universities. The training needed for educational practitioners ought to occur in similar contexts, in my judgment. Public/private consortia represent the most feasible arrangements to deal with the need for hardware and software, as well as attacking the funding problems related to the successful adaptation of microcomputer technology in the schools.

Resolution of the problems related to finding at the national level must be based, in my view, on immediate Congressional action. The time for study is past, it is now time for action! One of the more useful reports which I have found was done by Stanley Pogrow, of the University of Arizona, for the National Institute of Education School Finance Project. The report is entitled, "Technological Change: Policy Implications for Funding and Delivering Educational Service in the 1980's." I believe that this report could be of utility to the members of the Subcommittee in deliberations about these issues.

Legislation is already pending in the Congress to change the tax laws to make it feasible for computer manufacturers to donate hardware to the nation's schools. I believe that some form of public policy revision must make this possible. The schools will need to be exceedingly careful about what they accept from computer manufacturers, but I believe it is in the mutual interest of the hardware manufacturers and the schools to learn how to deal with each other in ways to provide mutually positive outcomes. I urge members of these two Subcommittees to review these issues and to use your influence to revise the tax laws in ways to make feasible the donation of computer hardware to the schools.

From a national perspective, the cost of providing hardware and appropriate quality software in the schools of the country is relatively low. The per student annual cost for providing each student with access to computer equipment with quality software for 30 minutes per day is approximately $25 per year.

V. PARENT OBJECTIONS

During the past several years, I have found very few objections by parents to the utilization of computers in the schools except from persons who are concerned about the general issue of growing school costs. In my experience, objections to students using computer hardware or the participation of students in learning about computers focus on the lack of such opportunities in the schools.

In Fairfax County, Virginia (which may be a somewhat atypical sample), numerous PTA and other parent organizations have been purchasing computer equipment, establishing and paying for tutoring programs for elementary students, organizing volunteer groups to provide computer literacy programs, and lobbying the school board, superintendent, and county government for increased emphasis on these kinds of programs. In other school systems across the country where there are organized volunteer programs there is a growing presence of so-called "computer tutors". These volunteers work with elementary and secondary students in programs which focus on the computer as an object of study, and they also facilitate computer science experiences, and application of computers to mathematics and science courses.

Two years ago in Fairfax County, the School Board appointed an advisory panel of executives from high technology corporations in the community to review recommendations which had been in the annual budget for the school system in regard to

the utilization of computers. That panel of professionals, many of whom were parents of students in the system, recommended that the school system develop a master plan for the utilization of computer technology, and strongly urged the Board to support allocations for purchasing hardware, software, and for appropriate training.

In summary, I have not found any substantial parental objections to the use of computers in the schools. Neither have I discovered in the professional literature any reports of objections which could be identified as a barrier to successful adaptation of this technology in the schools.

VI. TEACHER OBJECTIONS

While there is no complete concensus about the reactions of teachers to the advent of computer technology in schools, there are many that believe that teachers, in general, are suspicious and skeptical about the use of computers in the schools. This reaction is due, in part, to the inappropriateness of some machines for school use, and to the poor quality of some of the software. Some teachers have been told that computers will save time, which could mean that there could be reduction of staff by using computers. Because of this, some teachers believe computers threaten their job security.

My experience leads me to believe that this is not a realistic expectation. Instead, it seems more reasonable to expect that the role of the teacher will change. It is neither desirable nor likely that computers can be used to replace the vital functions which teachers perform to facilitate learning. However, it does seem apparent that, as computerized methods and materials become more effective, teachers' roles could shift from delivering information to managing the instructional process. Teachers could have more time for guiding individual progress while computerized resources perform time-consuming activities. Thus teachers could be more effective and more creative, but this also means spending more time developing materials and programs and so there tend to be conflicting representations and expectations on the part of teachers about the use of computers in the classroom.

However, during the past two years I have spent more than 50 full days in local schools talking with teachers and other local school personnel. Among these persons I have found a high degree of acceptance of the potential of computer capability provided that teachers and other school personnel can learn how to use these machines. A growing number of teachers have bought computers on their own, or they have "bootlegged" the machines into the schools by promoting the purchase of machines by PTA groups or other volunteer support organizations. Some teachers have acknowledged that they understand that the potential for staff reduction exists, but they do not see that really happening. Others indicate that they believe teacher organizations and unions promote this idea for their own reasons.

It seems very clear that teachers would respond to sound training and could utilize computers intelligently as the machines and quality software can be made available to them. However, training is a wide-spread problem. The results of a recent survey of more than 130 teachers education institutions in the Southeastern states indicates that less than half of those institutions offer any kind of in-service training on microcomputers for the education faculty. Fifteen percent of the responding institutions indicated that they developed and offered at least one specific course for pre-service teachers to acquaint them with the use of the microcomputer for instruction and/or management in the classroom. Twenty-three percent in the institutions indicated that they have such a course for in-service teachers. The survey findings underscored the fact that there is very little training in microcomputers available to practicing teachers or to those majoring in education in preparation for teaching. David Moursund, a professor of computer science at the University of Oregon, estimates that as few as five percent of the approximately 1,350 teacher-training programs in the United States offer undergraduate courses in computer education and that a small fraction of those now include such courses in their degree requirements.

The introduction of computers into the classroom raises many issues which teachers need help in thinking through, but education officials agree that there are several key reasons for the gap between teacher-training programs and the growing need to prepare teachers to use computer technology. These include declining enrollments combined with budget cuts, the fact that qualified computer instructors are rare, and the realization that it takes a tremendous effort and commitment of time to learn the technology well enough to teach on a college level. Often those faculty members who do decide to make such an investment find themselves receiving little support from their institutions.

Suffice it to say, that the need for training is clear and obvious. There must be efforts to improve pre-service programs and to develop linkages between school systems, universities, and private sector organizations (including computer manufacturers and publishers) so as to facilitate intelligent training programs.

A number of the persons with whom I have talked over the past three or four years have argued for the establishment of federal support based on a National Defense Education Act model which supported the development of mathematics and science teachers in the 1960's. I believe that such action would be desirable, particularly if it were structured so as to promote intelligent associations between school systems, universities, and appropriate private sector organizations.

As training is made available, I am persuaded that teachers' objections will be reduced substantially, and the acceptance of computer technology by classroom practitioners is the key variable to the successful adaptation of this technology in the schools of the United States.

VII. EFFECTS ON CHILDREN

Educational literature presents a variety of concerns about the effects on pupils of using computers in the schools. Some of these concerns focus on whether or not instruction will become impersonal as we learn how to adapt and use computer technology. Some people envision a scenario of future education where students are totally isolated from human interaction during learning, and as a result, become robot-like, unsocialized, and conformist.

Other observers suggest that our increasing reliance on computers in the home, as well as in the school, will result in even worse alienation than has been brought on by the national addiction to television. Some of these concerns are counteracted by writers who argue that television, in its present mode of delivery, has more potential for alienation than do computers. Another concern is represented in the game parlors which have spung up all around the country during the past year or so. Video games, which utilize microchips, and computer games, available in wide variety from computer manufacturers, have engendered controversy among educators interested in utilizing computers. Some favor the introduction of computer literacy, for example, by means of a games approach. They believe games are a natural way for children to interact with computers and they argue that the algorithms of mastering a game program are "discovered" thus leading to more constructive kinds of computer activities. One elementary principal with whom I have talked disagrees with this. In a memorandum which he furnished me within the past few days, Principal Richard Lavine has pointed out:

In talking to parents whose children have computers, games become the dominant use for computers unless children receive instruction in other uses of the machine. While some companies feel that prepackaged games can introduce children to programs and other applications, they and parents who advocate later introduction to computers into the schools fail to take into account the peer interaction variable. Children working together toward common ends spur one another on. Handled correctly, the encouragement children receive from their peers can go far in moving students toward becoming computer literate. For example, people who exercise together are far more likely to continue that exercise rather than those who exercise alone. Many parents have found that children at the elementary level respond better to instruction at school than they do at home.

As Principal Lavine implies, the effects of computer games, the potential for alienation, and concerns about impersonal instruction all reflect, in my judgment, a need for study and research concurrent with action to adapt computer technology in the schools.

There are other issues related to concerns about the effect of computer technology on pupils, and probably the major issue is that of equity. The distribution of classroom computers in schools across the country could split the nation's students in the classes of "haves" and "have nots" unless interventions assure that the access to technology and its use are provided in more poorly funded schools as well as those students in more affluent communities. However, equal access to computer technology for all students does not necessarily guarantee appropriate use of the technology. Exclusive concentration on the computer for drill and practice on a subject is a particular problem for students in non-affluent schools where computers are present. Some studies indicate that in these settings schools tend to control the learning environment by limiting the use of hardware to remedial instruction. For these and other reasons equitable access to computer technology is clearly a major issue deserving attention and research.

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Just as clear, however, is the logic of assuming that the lack of computers provides negative effects on children in regard to the future. Because work is becoming increasingly technical, those pupils who acquire only minimum competencies (as these are currently defined) will be functionally illiterate and unemployable by 1990. The use of computers with quality courseware by well-trained teachers can prevent the problems of functional illiteracy and lack of employability. Perhaps author Isaac Asimov has summed up this situation best when he wrote, "I do not fear computers. I fear the lack of them."

VIII. EFFECTS ON SOCIETY

Much of the literature about computer applications in education includes some opinion about the impact of computers on society. Often the primary emphasis is on positive impacts of computers, but some treatment of potentially harmful aspects of computers are also usually included. One of the most common examples deals with issues related to the invasion of privacy. In my view, not many writers have considered seriously the changes in social, political, military and economic decision-making because of the use of computer-based models, or changes in the nature of social organizations brought about by widespread computer use. Much of the literature also lacks any treatment of the concern for the particular social values imbeded in a given social application of computers. One computer application may support the values and goals of one social group and be harmful to other groups, but this type of issue is infrequently considered in the literature available to school practitioners.

Daniel Watt, a researcher associated with the Massachusetts Institute of Technology, has written about the effects on society by examining the impact of computers on peoples' lives. Watt points out that in the past only a small percentage of the population was directly concerned with computers in their work. Computer workers included technicians programmers, and computer scientists who required specialized technical training. People who, heretofore, have made use of information processed by computer only had to be comfortable with reading computer printouts. In the future, however, Watt expects the overwhelming majority of our working population to have significant interaction with computers as part of their daily work. As the economy becomes more dependent on information processing, those whose work involves such information will need to have a great deal of direct involvement with computers. He believes that word processors connecting with computer-based filing, copying, and communication systems will transform the nature and conditions of office work. Automation based in computer utilization will raise issues of control of the work environment, as well. Information systems not only improve an organizational ability to produce and distribute a product, such systems also provide managers with an unprecedented degree of control over the functioning of employees whose work requires interaction with the system. What Watt calls "big brother in the work place" may become as significant a labor relations issue as replacement of workers by automation has been in the past.

Watt is also concerned about the impact of computers in the personal life of Americans. He points out that in the past, most peoples' contact with the computers was limited to receiving computerized bills, and only a somewhat isolated minority had access to computers for professional or recreational pursuits. We can already see dramatic increases in the contact between individuals and computer systems in their daily lives. Personal computers and special purpose computer devices are becoming available in the homes of many people for family business, household management, intellectual and educational development, recreational activities, and creative expression. Watt believes that personal computers will eventually have as much impact in the daily lives of Americans as the automobile and television. He also expects that there will be mind-expanding effects for many people who learn to program their home computer and use them as creative personal tools for writing, composing and playing music, graphic arts, animation, communication, and information retrieval. For some people there may be less positive effects if they become independent on limited forms of computerized instruction or addicted to fast paced and exotic, but fundamentally meaningless, computer games.

One group of observers, calling themselves "The Techno/Peasant Survival Team," believes that our culture is being divided into two groups of individuals known as techno/peasants and technocrats. Technocrats are persons who understand computer technology and its potential. Techno/peasants, by far the majority of the citizenry, are those we are either overwhelmed by what is going on in the various new fields of technology or those who are too uninformed to have any real say in their future. What technocrats comprehend that sets them apart from techno/peasants is

that the processes of innovation now taking place represent power to change virtually everything around us. The "Survival Team" argues that our ability to process and manipulate information on a large scale has the significance for human evolution of the development of written language or the invention of the printed book. They believe that the most revolutionary aspect of computers is that they are the first invention ever to significant extend human capabilities. This means that the potential of computers is unique in human experience we have never been threatened by anything—animate or inanimate—that would equal, extend, or possibly surpass our own intellectual capacities. Unitil now.

In a fascinating book,The Techno/Peasant Survival Manual, the "Survival Team" argues that if we want technology to liberate rather than to destroy us, than all of us who are techno/peasants have to assume responsibility for it.

The implications of such a claim for the schools of the United States seem obvious. The schools are the social institutions on which our culture places the most direct responsibility for information and understanding to enable any citizen to assume responsibility in his or her own life for the effects of computer technology.

Stanley Pogrow, in a recent research report commissioned by the National Institute of Education, has written about effects on American society from an economic perspective. Pogrow believes the U.S. is experiencing economic changes today that have not been paralleled since the Industrial Revolution, when employment and production shifted from the farm and the home to the factory. Such dramatic changes necessarily impose new realities on both business and education. Today the business sector is being forced to change its traditional management strategy of investing in labor rather than in such other forms of capital as plants and equipment. U.S. business—like education—was enormously undercapitalized as the Eighties began. Production efficiency fell dramatically as the costs of energy and labor increased. U.S. products began to lose their competitive edge in the world market as the compelling economic advantages of more technologically efficient production techniques overwhelmed traditional marketing strategies and consumer preferences. In an era when technology makes it possible to replace labor with intelligent machines and physical distribution systems with communications systems, labor-intensive approaches to production are no longer viable. To remain competitive, U.S. industry is now forced to modernize its technology.

As an economic pragmatism fuels the adoption of new production methods, the cumulative impact of these changes will be to alter the nature of work. Most workers, be they artists or machinists, will increasingly have to perform tasks that are science-related. By the time that most students who are now in elementary schools finally enter the world of work, this shift in the nature of work will be largely a reality.

Because work is becoming increasingly technical, those students who are not literate about computers and who do not have better preparation in math and science, than is now the case for many high school graduates, will be as functionally illiterate and unemployable in 1990 as are individuals who do not possess such competencies today. Pogrow argues that this truth will become apparent to the general public by the mid-Eighties; the public, in turn, will demand that the schools adopt a curriculum that is technologically relevant.

Pogrow identifies "technological relevance" as a comprehensive restructuring of curriculum. A technologically relevant curriculum must not only provide the specific skills necessary for effective uses of particular technologies; it must also prepare all students to engage in sophisticated forms of reasoning. This new curriculum must break the distinctions that now exist between: (1) children who are expected to learn how to think in a mathematical mode and those who are not, (2) "artistic" activities and "technical" activities, and (3) the liberal arts and the sciences.

Professor Pogrow also believes that the present economic changes are so radical that even the largest corporations will probably be unable to shield themselves from the effects of a phenomenon he calls "environmental collapse." Environmental collapse occurs when dissatisfied constitutents and clients do not try to change an organization; instead, they abandon it for an economically compelling alternative made possible by a fundamentally new technology. History provides numerous examples of victims of environmental collapse. These include scribes, artisans, ocean liners, the Pony Express, and—quite possibly—the Chrysler Corporation, newspapers, and the U.S. Postal Service.

Environmental collapse is a force driven by economics and changing preferences that are immune to traditional political strategies. Thus, according to Pogrow, public schools that ignore demands for a technologically relevant curriculum will risk substantial declines in enrollment. Pogrow believes technological relevance will

be the busing issue of the Eighties—the issue whose outcome will determine whether the public schools can retain the children of the middle class.

A number of observers believe the lack of "technological relevance" coupled with the widespead availability of computers and other technological devices in the home could lead to rejection of formal schooling. Pogrow acknowledges this danger, but he believes, as I do, that such a response is unlikely, given the socialization functions of formal schooling and the fact that more and more parents are joining the workforce. But home-based educational technologies could change taxpayers' minds about the number of years of formal schooling that they are willing to support. Most likely, home technologies will soon provide instruction for all children in the basic skills; parents and the general public will then expect the schools to provide the more creative and technologically relevant learning and socialization activities.

The United States cannot afford to abandon its public school system for lack of "technological relevance" or for any other reason. The schools of America are where we all learn to live together, they provide the "social glue," as it were, which binds us into a nation. We must take appropriate action nationally, regionally, in each state, and locally to assure that rising public expectations for relevant learning and socialization activities can be fulfilled in the public schools of the country. This means action in regard to the adaption of computers in our schools.

IX. PROPOSAL FOR ACTION

Please note that this section is entitled, "Proposal for Action." While there are many issues which need research and study it is quite clear that the time has come for national action in regard to the use of computer technology in the schools of the nation.

In an earlier section of this presentation, I identified three areas of focus for the funding problems related to the use of computers in the schools. These are (1) the costs of computers themselves, (2) the costs related to the development of quality courseware, and (3) the training needs which exist in the schools. I believe that it is impossible to underestimate the need for training and development for educational practitioners. I have tried to emphasize this need in several sections of this presentation, and I want to reemphasize that both classroom practitioners and educational managers need support and assistance in learning how to utilize the potential represented in the application of computers in schools.

Educational managers need help in thinking through the issues of how to develop new budgeting philosophies and techniques so as to find ways to make it possible to put computers in the schools and provide the programs necessary to work with university and private sector personnel in these efforts.

I want to emphasize in the strongest way that focusing on the training needs of teachers without giving attention to the needs of educational managers to learn how to help teachers get the job done would be shortsighted at least and wasteful at worst.

Support systems for intelligent use of computers in the schools cannot be built nor maintained unless principals, superintendents, and other educational managers have opportunity to become literate in regard to machines and develop the understanding necessary to oversee and facilitate appropriate program development. Sound decisions about the purchase of courseware as it may be developed in the private sector must be made, also, and such decisions ought to be made by educational managers who have had opportunity to consider the issues involved in training and renewal situations.

In an earlier section of this presentation, I have tried to make a strong case for the training needed by teachers. Teachers need help in working out new techniques for classroom management and program development. Because it is neither desirable nor likely that all instruction should take place by means of computerized methods it is necessary for intelligent decisions to be made about how much time should be spent in individualized methods of learning as compared to group activities. Teacher preparation programs and in-service programs for teachers must be given attention concurrently.

With these reminders about the importance of training for educational practitioners. I wish to recommend action in the form of a 5-year implementation program involving components of training, software development, and software acquisition. The emphasis on such a program perhaps could be focused best on approving math and science education by utilizing computers in the schools. In any action program, I believe that the Congress ought to set aside ten percent of the appropriations for research and development related to the objectives of the action program.

One way to begin action would be to focus on secondary math and science teachers. In my judgment, an action plan of this sort ought to focus on providing training for about 33,000 math and science teachers each year for the next five years, and 2,000 for educational practitioners—principals, curriculum coordinators, and other educational managers. Minimal costs, to be used in a "NDEA Training Model" would be $10,000,000 per year for the next five years ($200 × 35,000 teachers/educational managrs).

A reasonable estimate for the current investment in the development of courseware or educational software would be about $10,000,000. I believe Congressional action ought to double the present investment for the next five years, that is, allocate $10,000,000 per year for software development. These allocations ought to be made in such a way as to nurture consortia of public and private organizations. Combinations of school systems, corporations, and universities along with nther appropriate agencies are the best context for the development of quality courseware. Moreover, the suggestion of $10,000,000 is based on an assumption that this would match the current investment of publishers and developers in the commercial sector, and this public expenditure would be best made by requiring matching efforts from the private sector so as to support consortia for the appropriate development of quality software programs.

The schools must acquire the software as it is developed, and I urge that appropriations for software purchase should be a part of national action. Assuming that about 20 percent of the currently enrolled students in the secondary schools of the nation are involved in mathematics and science programs, I suggest an hnvestment of about $20 per student. This would amount to $50,000,000 per year for each of the next five years. This would not only enable schools to invest in software, but it would provide the motivation for and a realistic fiscal boost to the adaptation of such programs in math and science education throughout the country.

In summary, I recommend a program of action to focus on improving math and science education through the use of computer technology over the next five years involving components of educational practitioner training, software development in public/private consortia, and software acquisition in the schools. The total cost of the program would be $350,000,000 over the next five years, or $70,000,000 per year. A set aside appropriations for research and development on the issues and problems involved in the adaptation of computer technology in the schools should amount to $7,000,000 per year for each of the next five years.

Any program of action should also include a review of law and other public policy as well as funding. As was pointed out in earlier sections of this presentation, attention needs to be given to tax laws and copyright laws so as to facilitate the development of needed courseware and to enhance the feasibility of computers being made available to the schools in a wider variety of options than now exist.

I urge the members of these two Subcommittees to do everything possible to implement a program of action such as has been herein suggested. Thank you very much for the opportunity to suggest these actions on behalf of the young men and women who make up the student bodies of the schools throughout the United States.

Mr. BIAGGI. Mr. Miller.

STATEMENT OF JOE MILLER, MIGRANT STUDENT RECORD TRANSFER SYSTEM, ARKANSAS STATE DEPARTMENT OF EDUCATION, LITTLE ROCK, ARK.

Mr. MILLER. Mr. Chairman and members of the House Subcommittee on Select Education and the House Subcommittee on Elementary, Secondary, and Vocational Education, and guests of the hearing, I am Joe Miller, director of the National Migrant Student Record Transfer System, Little Rock, Ark., Department of Education.

Mr. Chairman, I would like to request that my entire text be made part of the record with my comments.

Mr. BIAGGI. Without objection, so ordered.

Ms. Hakansson, I think your extemporaneous remarks might be more elaborate than your written statement. I might suggest that

that be included instead of your written statement. It is more informative, as well.

Thank you.

Mr. MILLER. I am most appreciative for this opportunity to speak to you about the use of technology in education and about how the migrant student record transfer system was initiated.

Some 8 or 10 years ago, I appeared before this panel and testified regarding the migrant student record transfer system. At that time, there was bipartisan support for the migrant student record transfer system, and there continues to be. It has been the forerunner in technology in the areas of education and health for the past 14 years. It is probably the most innovative and most functional current effort in the field of education.

The rapidity with which migrant children have moved during school terms has created a problem where many schools never receive a student record on their migrant children until they have already moved, if they receive a record at all, which causes the data to be practically useless. The slowness of record transmittal occurs even though the child has moved only within the city, within the State, or between States. We have had two foreign countries and two large city school districts who have emulated this system because of this great problem. Thus, educators in migrant education knew that this state of affairs was far from what was needed for them to properly administer a program for mobile students.

I want to emphasize that the migrant student record transfer system, Mr. Chairman, was in 1968, and continues to be today, a product of States that use it, and it was not developed by a Federal bureaucracy. Many persons have recognized the problem of transferral of records for many years.

In 1966, you, the Congress, demonstrated its recognition of the interstate nature of farm migrancy by passing Public Law 89-750. The 48 States moved expeditiously to follow your mandate following a Conference of States in Phoenix, Ariz., in February 1968. A committee called the Record Transfer Committee was organized to develop a system and a document to be used in transferring data from school to school. Two facts were soon discovered: One, to be effective, MSRTS had to be a national effort; and two, it also had to be an automated system.

MSRTS was the first massive interstate cooperative effort instituted by Public Law 89-750 funds. It provides literally thousands of people a cohesive structure within which they may cooperatively devise and implement programs of education and health care for more than 800,000 disadvantaged students. The system became a defined concept in 1968, a project in 1969, an operational instrument in 1970, and a national reality in 1971. As a concept, the system is unprecedented and, as a working success, it is unprecedented.

The MSRTS interacts within its nationwide educational and health services environment in a health manner since it shapes and, in turn, is shaped by that environment. It assists teachers, nurses, medical advisers, doctors and practitioners, and all levels of administration in discovering new and relevant dimensions of education. Hence, it helps them uncover new informational needs to

support the decisionmaking processes so necessary to those new dimensions. These discoveries, in turn, require the system to be responsibly responsive to its users and insure that the newly emerging needs are met.

Had it not been for technology in the development of this system, today we would continue to see thousands of migrant children dropping out of school for the simple reason that their credits would never be accrued or transferred. MSRTS is the heart of the migrant program since it enables the migrant child to have the same chance to receive a quality education as all other children of our Nation.

When the system started in 1968, about the highest attainment any migrant child received in school was the eighth grade. Because of technology, 5,000 to 6,000 migrant children are graduating from high school each year. MSRTS is the major mode by which meaningful information is disseminated to participating States about new special programs which have been designed to help alleviate the educational shortcomings of our public school system.

The migrant child is a child of the Nation and, as such, his education must continue to be of considerable concern to all educators of the Nation and our Congress. Without the migrant education program and without its heart, the migrant student record transfer system, the end result most probably would be that 800,000 children would not receive their just education and health care.

There are three basic communication elements in MSRTS: The school, the terminal, and the computer. The school initiates all information that goes into the student record. The data entry specialist transmits the schools' data to the computer which processes, stores, and disseminates information according to these requests.

MSRTS offers rapid turnaround service to schools. This rapid service reduces the lost time in planning health and academic programs for migrant children. Four basic reports are provided a school upon the enrollment of a migrant student.

The first report is returned to the terminal that services the requesting school in a matter of a few seconds or minutes. This report is called the Critical Data Report which contains information from the previous school of enrollment: First, student identification; second, program types; third, chronic conditions; fourth, innoculations; fifth, reading ability ratings; and sixth, math concepts ratings.

In addition to the speed capability of MSRTS, another important feature is flexibility for change. The transfer record has undergone several changes since its inception to assure maximum data utilization at the school level. The transfer record is presently undergoing some major changes which is dictated by the State directors and their committees who work directly with the migrant children in the country.

There are approximately 22,000 schools that receive these services, and approximately 300 health clinics which feed educational and health information on migrant children into approximately 175 data collection locations which, in turn, relay this information via the telephone network to a host computer in Little Rock, Ark. The information is stored and awaits the child's (student's) departure from the school in which he is currently enrolled. While the

student is in his current school, relevant date is sent to the host computer keeping his record up to date. Upon his withdrawal from his current school and his subsequent enrollment into his new school, an individualized record is mailed to his new school conveying information about his educational and health experiences in the school from which he was recently withdrawn. This record arrives within a matter of 2 to 3 days.

Other selected and predefined information will be returned to the terminal serving the new school on the same day that the enrollment transaction is received by the host computer. This other critical data is scanned for certain relevant information and is phoned to the student's new school if warranted.

There is an abundance of technology waiting around the corner brought on by the increasing use of microcomputers in the educational environment. I would like to quote Dr. Frank Brouillet, superintendent of public instruction from Washington State, as he addressed educators in his State:

> During the 1970's, there was a commercial on television to raise funds for United Negro Colleges that ended with the statement, "A human mind is a terrible thing to waste." Despite the present economic belt-tightening, a human mind is still a terrible thing to waste, particularly when we have demonstrated that there is no need to waste it by refusing to educate, defraud it by lack of commitment or abuse it by failing to recognize its needs.

We have heard from several here this morning about what is needed in the area of technology before it is placed in the school systems.

Dr. Brouillet went on to say:

> That educators were reluctant to embrace the world of computer technology. Within the past 5 years, the role of computers in our society has expanded to the point that this will be considered the age of the computer, much as the 19th century is referred to as the age of industrialization.

In the same view of computers and their relation to the educational environment, Dr. Brouillet had the following to say:

> You will be interested to know that we now have a computer technology and instruction task force at the State level which will be sponsoring statewide workshops dealing with how to select computer hardware and to evaluate courseware.

Mr. Chairman, I would like to tell you that, as I travel over the country working with the States, I am seeing this take place in many, many States. Much hardware is being bought not knowing exactly how it is going to be used and, consequently, are turning some people off when it should not occur. "Judging from the increasing requests we have for microcomputers, I am certain this is an area of interest to many of you."

While Dr. Brouillet's comments about computer technology and its significance to educators are appropriate, it must be stated that he is not alone in his assessment of the future of the microcomputer in the classroom. Many States are fast approaching the concept just stated by Dr. Brouillet. In fact, through the use of technology, systems are being established like MSRTS in our big-city schools and all across the country, but they are carrying it right down to the classroom itself.

There has always been a need in every classroom across our Nation to tailor instruction to the needs of the individual. A movement was evident in the late 1960's and early 1970's to individual-

ize instruction. This attempt was unsuccessful not because of commitment to the concept, but largely to the inadequate support given to the teacher in the classroom who was inundated with the preparation of educational materials necessary to serve individuals, and also because of a lack of a recordkeeping system for individualized instruction techniques.

Recognizing that the attempt to individualize instruction largely failed does not negate the fact that a need still exists to tailor a child's educational experiences to his abilities. Here is where I think technology can certainly be a factor in this area. Technology will not replace the teacher; technology will allow the teacher to get away and do other things and tailor a child's educational experiences according to his abilities. A child must be taken from where he is, educationally speaking, and moved ahead at an appropriate pace. Technology will allow this.

There is an increasing awareness among educators that technology can help with this individualized educational process. The demand is growing in the educational domain for a system that can assist in the educational process but that will not dictate to the teacher or pose the threat of replacing the teacher. For those teachers who are confident of their skills and who are unafraid of technology, the transition will be easy and immensely rewarding for them and their students. For other teachers, the transition will be a little longer in occurring, but as they see the benefits of the microcomputer, their resistance will diminish and, over the next 10 years, their fears will evaporate.

The effect that it will have on the student will be positive. It will enhance the student's creative problem-solving skills. It will enhance the student's ability to communicate. It will enhance the student's analytical skills. It will increase the student's awareness of current technology and its potential. It will move education in the direction of being more fun. The student will be actively engaged and not a spectator. The student will learn to use a powerful tool which will, in turn, help develop future tools. It will open jobs streams which students may enter. It can remediate existing deficiencies in the student's educational background.

State directors of migrant education and MSRTS officials are looking at all types of technology in education to further tie the classroom teacher more closely to MSRTS. This will be the third step in a cycle. As previously stated, migrant educators have been the forerunners in tying technology to education, health and welfare of the migrant child. They have also been the forerunners in establishing the basic skills in reading, math, early childhood and oral language for all migrant children. To fully complete the technological cycle, a committee convened under the directorship of the State director of migrant education in the State of New York to develop courseware and software in these four domains that can be used in the classroom with microcomputers to complete the total educational cycle that they set out to do.

In the State of Michigan, migrant educators, by placing terminals in the schools, have largely learned to identify vocational aptitudes which early in a student's educational career pinpoints those career goals for which the student is best suited both by student interest and student aptitude. By so identifying these potential

career associations, the schools are able to plan vocational experiences that maximize future adult job satisfaction.

What are the benefits of MSRTS? It provides the educators information which they can use to plan programs. It provides teachers and nurses with information on an individualized basis which enables them to better meet the needs of the migrant child. It provides an ongoing forum for problem identification and solution seeking which does not exist on a comparable level elsewhere in our Nation. It helps to make a healthier environment for our Nation's migrant population. It helps to identify potential health epidemics.

I would like to, Mr. Chairman, bring to your attention of two such epidemics. One was a typhoid fever outbreak in Florida some 2 or 3 years ago where 215 migrant children were susceptible to having typhoid fever moved out, and the system was able to locate them after only 6 hours after the notice was received in Little Rock, Ark., and they got the care and treatment of a doctor.

This past summer, a smallpox outbreak was reported in the Valley in Texas where 40,000 migrant children were susceptible. These children were located in very short order and got under the care and treatment of a doctor.

So it does have great benefit in preventing potential health epidemics. It helps smooth out the gaps in a migrant student's educational experience.

Has it been a success? Success is difficult to measure. One measure of success is identified by those agencies which come to our system for data. Over the past dozen years, the MSRTS has been studied and emulated or its data used by the following national bodies: the Department of Health, the Census Bureau, the Communicable Disease Center in Atlanta, the Department of Agriculture, the Department of Defense, the Bureau of Indian Affairs, the U.S. Department of Education, Chief State School Officers, and the Office of Vocational and Handicapped. We have just now completed a contract with the Rehabilitation Services and have now started providing them data also meeting the experiences that are needed in the area of rehabilitation.

Mr. Chairman, if I have any comments to make regarding what should be done by the Congress of this Nation is that there should be a national commitment made on the part of Congress and moneys put into practical use that can be used in an orderly fashion so that the transition to technology in the classroom can be brought about in an orderly fashion. That is not happening today. There must, as this panel has already directed, be research and development before technology is placed in the classroom.

I would leave you with that recommendation.

Mr. BIAGGI. Thank you, Mr. Miller.

[The prepared statement of Joe Miller follows:]

PREPARED STATEMENT OF JOE MILLER, DIRECTOR, MIGRANT STUDENT RECORD TRANSFER SYSTEM (MSRTS), ARKANSAS STATE DEPARTMENT OF EDUCATION, LITTLE ROCK, ARK.

WHY THE NEED FOR MSRTS?

The rapidity with which many migrant children have moved during school terms has created a problem where many schools never receive a student record on their

migrant children until they have already moved if, they receive a record at all which causes the data to be practically useless. The slowness of record transmittal occurs even though the child has moved only within the city, within the state or between states. Thus the educators in migrant education knew that this state of affairs was far from what was needed for them to properly administer a program for mobile students. I want to emphasize that the Migrant Student Record Transfer System was in 1968 and continues to be today a product of the states that use it and was not developed by a federal bureaucracy.

Many persons have recognized this problem for many years. Recorded efforts to establish a record transferal system date back to the 1940's. However, not until the passage of Public Law 89-750 as an amendment to Public Law 89-10 in 1966 was there a unified effort in this country to accumulate and distribute pertinent student data on migrant chidren. It became obvious that neither an individual state nor a region of states could, upon self-initiative, make and sustain an adequate system of transferring student data. It had to be a national effort. In 1966 Congress demonstrated its recognition of the interstate nature of farm migrancy by passing Public Law 89-750 Section 103(c)(1)(A):

"that payment will be used for programs and projects (including the acquisition of equipment and where necessary the construction of school facilities) which are designed to meet the sepcial educational needs of migratory children of migratory agricultural workers, and to coordinate these program and projects with similar programs and projects in other states, including the transmittal of pertinent information with respect to school records of such children."

The 48 states moved expeditiously to fulfill your mandate. Following a conference of states in Phoenix, Arizona in Feburary, 1968, a committee called the Record Transfer Committee was organized to develop a system and a document to be used in transferring data from school to school. The first effort was on a manual basis—all work was done physically. However, two facts were soon discovered: (1) to be effective MSRTS had to be a national effort and (2) it also had to be an automated system.

MIGRANT STUDENT RECORD TRANSFER SYSTEM—GENERAL

The MSRTS was the first massive interstate cooperative effort instituted by Public Law 89-750 funds. It provides literally thousands of people a cohesive structure within which they may cooperatively devise and implement programs of education and health care for more than 800,000 migrant students. The System became a defined concept in 1968, a project in 1969, an operational instrument in 1970 and a national reality in 1971. As a concept, this System is unprecedented—as a working success, it is unprecedented.

The MSRTS interacts within its nationwide educational and health services environment in a healthy manner since it shapes and in turn is shaped by that environment. It assists teachers, nurses, medical doctors and all levels of administration in discovering new and relevant dimensions of migrant education—and hence, it helps them uncover new informational needs to support the decision making processes so necessary to these new dimensions. These discoveries in turn require the System to be responsibly responsive to its users and insure that the newly emerging needs are met.

Had it not been for technology in the development of this System, today we would continue seeing thousand of migrant children dropping out of school for the simple reason—their credits are never accured. MSRTS is the heart of the migrant program since it enables the migrant child to have the same chance to receive a quality education as all other children of our nation. When the System was begun in 1968, about the highest attainment any migrant child received in school was the eight grade. Because of technology 5 to 6,000 migrant children are graduating each year. MSRTS is the major node by which meaningful information is disseminated to participating states about new special programs which have been designed to help allevate the educational shortcomings of our public school system.

The migrant child is a child of the nation and as such his education must continue to be of considerable concern to all educators of the nation and our Congress. Without the migrant education program and without its heart, the Migrant Student Record Transfer System, the end result most probably would be that 800,000 children would not receive their just education and health care.

HOW DOES MSRTS WORK?

There are three basic communication elements in MSRTS: the school, the terminal and the computer. The school initiates all information that goes into the student

record. The data entry specialist transmits the schools' data to the computer which processes, stores and disseminates information according to those requests.

MSRTS offers rapid turnaround service to schools. This rapid service reduces the lost time in planning health and academic programs for migrant children. Four basic reports are provided a school upon the enrollement of a migrant student.

The first report is returned to the terminal that serves the requesting school in a matter of a few minutes. This report is called the Critical Data Report which contains information from the previous school of enrollment: (1) student identification: (2) program types; (3) chronic conditions; (4) inoculations; (5)—reading ability ratings and (6) math concerpts ratings.

A critical Data Report is generated as a consequence of two desired actions: (1) an enrollment where Critical Data is desired and (2) a request for Critical Data only. Since the requests are processed and responses immediately sent to the terminals serving the requesting school(s), it is possible for the migrant child to have the benefit of the Critical Data within minutes the same day as his enrollment. This reduces very significantly the evaluation time required prior to program planning.

The other three reports are an up-to-date migrant student record transfer form (transfer record), up-to-date medical record and the skills report of reading, math, early childhood and oral language which are mailed to the school initiating the action. The records are mailed the day following an update and usually arrive at their destinations within two or three days of the postmark.

A written survey was conducted with 105 sites in 12 states: Maine, New York, Pennsylvania, North Carolina, Florida, Texas, Colorado, Arizona, California, Oregon, Washington and Michigan. The records were delivered via first-class mail to 30.5 percent of the schools in two days with 36.1 percent receiving their records in three days. Our survey showed two-day delivery in the following states: Maine, Pennsylvania, New York, North Carolina, Florida, Texan, California and Colorado.

This reduction of time in the transferral of student data from school to school adds many days, on the average, to the productive days each migrant student has in school at each location. Heretofore, the time lapse between a school requesting and receiving a student record from a previous school was a few to several weeks. Many times the child had already moved on to another school. This tended to create a "why should I try" attitude among school people. Knowing the student would, in many cases, be in a given school for only a few days or a few weeks at most, it was easy to rationalize, "there's no use in requesting a record; the student will most likely be gone before it arrives; so I'll let him bide his time with some activity (maybe crayons and paper) while he is here."

MSRTS is helping do away with this kind of rationalization by providing pertinent data on a rapid basis which, in turn, generally results in more attention given by the professional school staff to health and educational program development. Better programs and more attention given to student needs will tend to develop more holding power for schools. The greater the holding power, the better the education of participating migrant children.

In addition to the speed capability of MSRTS, another important feature is flexibility for change. The transfer record has undergone several changes since its inception to assure maximum data utilization at the school level. The transfer record is presently undergoing some major changes as dictated by the state directors and their committees who work directly with the migrant children in the country.

There are approximately 22,000 schools and 300 health clinics which feed educational and health information on migrant children into approximately 175 data collection locations which in turn relay this information via the telephone network to a host computer in Little Rock, Arkansas. The information is stored and awaits the child's (student's) departure from the school in which he is currently enrolled. While the student is in his current school, relevant data is sent to the host computer keeping his record up to date. Upon his withdrawal from his current school and his subsequent enrollment into his new school, an individualized record is mailed to his new school conveying information about his educational and health experiences in the school from which he recently was withdrawn. This record arrives at his new school within two to three days upon his reported enrollment into the new school.

Other selected and predefined information will be returned to the terminal serving the new school on the same day that the enrollment transaction is received by the host computer. This other "Critical Data" is scanned for certain relevant information and is phoned to the student's new school if warranted.

IS MSRTS RESPONSIVE TO CHANGE?

There is an abundance of technology waiting around the corner brought on by the increasing use of the microcomputers in the educational environment. I would like to quote Dr. Frank Brouillet, Superintendent of Public Instruction from Washington state, as he addresses educators in his state.

"During the 1970's there was a commerical on television to raise funds for United Negro Colleges that ended with the statement 'A human mind is a terrible thing to waste'. Despite the present economic belt tightening, a human mind is still a terrible thing to waste, particularly when we have demonstrated that there is no need to waste it by refusing to educate, defraud it by lack of commitment or abuse it by failing to recognize its needs."

Dr. Brouillet went on to say that, "educators were reluctant to embrace the world of computer technology. Within the past five years, the role of computers in our society has expanded to the point that this will be considered that age of the computer, much as the 19th century is referred to as the age of industrialization."

In the same view of computers and their relation to the educational environment Dr. Brouillet had the following to say: "You will be interested to know that we now have a computer technology and instruction task force at the state level which will be sponsoring statewide workshops dealing with how to select computer hardware and to evaluate courseware. Judging from the increasing requests we have for microcomputers, I am certain this is an area of interest to many of you."

While Dr. Brouillet's comments about computer technology and its significance to educators are appropriate, it must be stated that he is not alone in his assessment of the future of the microcomputer in the classroom. Many states are fast approaching the concept just stated by Dr. Brouillet. In fact through the use of technology systems are being established like MSRTS in our big city schools and other countries as well.

There has always been in every classroom across our nation the need to tailor instruction to the needs of the individual. A movement was evident in the late 60's and early 70's to individualize instruction. This attempt was unsuccessful, not because of commitment to the concept but largely to the indequate support given to the teacher in the classroom who was inundated with the preparation of educational materials necessary to serve individuals and also because of a lack of a record keeping system for individualized instruction techniques.

Recognizing that the attempt to individualize instruction largely failed does not negate the fact that a need still exists to tailor a child's educational experiences to his abilities. A child must be taken from where he is, educationally speaking, and moved ahead at an appropriate pace to where he needs to go.

There is an increasing awareness among educators that technology can help with this individualized educational process. The demand is growing in the educational domain for a system that can assist in the educational process but that will not dictate to the teacher or pose the threat of replacing the teacher. For those teachers who are confident of their skills and who are unafraid of technology, the transition will be easy and immensely rewarding for them and their students. For other teachers the transition will be a little longer in occuring but as they see the benefits of the microcomputer their resistance will diminish and over the next ten years their fears will evaporate.

The effect that it will have on the student will be positive also in that:

(a) It will enhance the students creative problem solving skills (the hard work will be done by the computer);

(b) It will enhance the student's ability to communicate (he must concisely state his desires);

(c) It will enhance the student's analytical skills (he must learn to think in terms of logic);

(d) It will increase the student's awareness of current technology and its potential;

(e) It will move education in the direction of being more fun (the student has more control over his progress);

(f) The student will be actively engaged and not a spectator;

(g) The student will learn to use a powerful tool which will, in turn, help develop future tools;

(h) It will open job streams which students enter; and

(i) It can remediate existing deficiencies in the student's educational background.

State directors of migrant education and MSRTS officials are looking at all types of technology in education to further tie the classroom teacher more closely to MSRTS. As previously stated migrant educators have been the forerunners in tying technology to the education, health and welfare of the migrant child. They have

also been the forerunners in establishing the basic skills in reading, math, early childhood and oral language for all migrant children. To fully complete the technological cycle, a committee of state migrant edcuators, chaired by New York's state director of migrant education, is presently in the midst of looking at microcomputers to be used in the classroom as an instructional tool, a teaching instrument and also as a management tool.

In the State of Michigan migrant educators have, by placing terminals in the schools, learned to identify vocational aptitudes which early in students educational career pinpoints those career goals for which the student is best suited both by student interest and student aptitude. By so identifying these potential career associations, the schools are able to plan vocational experiences that maximize future adult job satisfaction.

SERVICES OF MSRTS

The Arkansas Department of Education serves as the national headquarters of MSRTS. From its offices located in Little Rock, Arkansas, the MSRTS staff performs the following services: (1) Yearly contract proposal development, negotiation and execution. (2) On-site visits to terminals to give needed assistance. (3) Daily monitoring of all terminals for volume and efficiency control. (4) Provide all computer services. (5) Mailing of student educational transfer record forms. (6) Mailing of student medical records forms. (7) Mailing of student skills record forms. (8) Provides a recommended total system operation. (9) Develops and provides training materials for states. (10) Develops and provides operational manuals for data entry specialists and school users. (11) Provides monthly, quarterly and annual activity reports to USDE and states. (12) Provides training for all data entry specialists, backup data entry specialists and other state personnel. (13) Works with USDE and state agencies on operational development problems related to MSRTS. (14) Works with national committees in developing enhancements to the migrant program. (15) In-service training for MSRTS staff. (16) Monitors users' needs and modifies System accordingly with USDE approval.

MSRTS REPORTING SERVICES

Good management practices dictate that managers have a thorough understanding of the nature of activities in which they are involved. To this end, MSRTS provides summary data on a monthlx, quarterly and yearly basis to the state directors of migrant education.

The following is a list of items in a report for a given period: (1) Cumulative enrollments to date. (2) Number of students end of period. (3) Number enrollments. (4) Unique enrollments. (5) Number withdrawals. (6) Unique withdrawals. (7) Number of terminations. (8) Number days enrolled. (9) Number days present. (10) Number days absent. (11) Number interstate moves. (12) Number intrastate moves. (13) Screening exams given by type: (*a*) Physical; (*b*) Visual; (*c*) Audio; (*d*) Dental; and (*e*) Tuberculosis. (14) Number abnormalities. (15) Number urgent conditions reported. (16) Immunization given by type inoculation or vaccination: (*a*) 1101 DPT; (*b*) 1102 DT; (*c*) 1103 Measles (German); (*d*) 1104; (*e*) 1105 Measles (Red); (*f*) 1106; (*g*) 1107 Mumps; (*h*) 1108 Polio (inoculation); (*i*) 1109; (*j*) 1110 Polio (oral); (*k*) 1111; (*l*) 1112 Tetanus; (*m*) 1113 Influenza; (*n*) 1114 Typhoid Paratyphoid; (*o*) 1115; (*p*) 1116 Smallpox; and (*q*) 1117 Other. (17) Number of chronic conditions reported. (18) Number treatments recommended by type. (19) Number treatments actually performed. (20) Number treatments started. (21) Number treatments completed. (22) Total number students tested. (23) Number of students tested by test name. Some of the test names follow: (*a*) Wide Range Achievement Test; (*b*) Stanford Achievement Test; (*c*) California Achievement Test; (*d*) Botel Reading Test; (*e*) Arithmetic Achievement Test; (*f*) Metropolitan Readiness Test; (*g*) SRA Achievement Test; (*h*) Iowa Test of Basic Skills; (*i*) California Test of Basic Skills; (*j*) Sequential Tests of Educational Progress; (*k*) Child Development Analysis; (*l*) Gray-Votaw-Rogers General Achievement Test; (*m*) Peabody Picture Vocabulary; (*n*) General Aptitude Test Battery; (*o*) Iowa Test of Educational Development; (*p*) Other (1st); and (*q*) Other (2nd). (24) Number in programs. The list of identified program types are: (*a*) Health—recreation; (*b*) Preschool; (*c*) Tutorial services; (*d*) Cultural enrichment; (*e*) Remedial reading; (*f*) English as a second language; (*g*) Language development; (*h*) Vocational education; (*i*) Remedial mathematics; and (*j*) Other. (25) Number in other program types. (26) Number of students in each program type. (27) Academic characteristics for the following: (*a*) Reading ability; (*b*) Primary language; (*c*) Ability to communicate in English; (*d*) Speech disorder; (*e*) Hearing disorder; (*f*) Understand directions;

(*g*) Math computation; (*h*) Composition; (*i*) Science; (*j*) Social studies; and (*k*) Math concepts.

This information is compiled on the following levels provided the state identification number includes all these levels: (*a*) School plant; (*b*) School district; (*c*) County; (*d*) Congressional district; and (*e*) State.

A national summary is compiled on the same frequencies for the U.S. Department of Education.

In addition to the statistics reports mentioned above, MSRTS gives a report semimonthly to the state directors of migrant education a volume and proficiency report on each data entry specialist in his state.

Using the two statistics reports just described, each state director knows on a continuing basis how his schools and his data entry specialists are performing.

WHAT ARE THE BENEFITS OF MSRTS?

(a) It provides the educators information which they can use to plan migrant programs.

(b) It provides teachers and nurses with information on an individualized basis which enables them to better meet the needs of the migrant child.

(c) It provides an ongoing forum for problem identification and solution seeking which does not exist on a comparable level elsewhere in our nation.

(d) It helps to make a healthier environment for our nation's migrant population.

(e) It helps to identify potential health epidemics.

(f) It helps to smooth out the gaps in a migrant student's educational experiences.

(g) It promotes the idea of a quality education for migrants.

HAS MSRTS BEEN SUCCESSFUL?

Success is difficult to measure. One measure of success is identified by those agencies which come to your system for data. Over the past dozen years the MSRTS has been studied and emulated or its data use by the following national bodies: (*a*) The Department of Health; (*b*) The Census Bureau; (*c*) The Department of Agriculture; (*d*) The Department of Defense; (*e*) The Bureau of Indian Affairs; (f) The U.S. Department of Education; and (*g*) Chief State School Officers; (*h*) Office of Vocational and Handicapped.

Another method is to compare the number of records (educational medical and skills) mailed in August, 1981 to the number of records mailed in August, 1982. The MSRTS mailed 124,579 more records (educational, medical and skills) in August, 1982. This shows that more information is being transmitted to benefit more migrant students.

MSRTS SAFEGUARDS

It is appropriate that some mention of safeguards of private information be mentioned. The designers (a committee of twelve states and the MSRTS staff) of the Migrant Student Record Transfer System Form and the Automated Migrant Student Record Transfer System were very mindful to design and develop a total system that would assure privacy of data. The System, as it was designed, has met all standards as established by the U.S. Senate Subcommitteee on Constitutional Rights chaired by Senator Sam Erwin of North Carolina.

MSRTS POTENTIAL

It is my understanding that our national population is one-third mobile annually. This means there is a large volume of student record transferrals from school to school. The MSRTS has the potential to expand to serve any part of all of this record transferral requirements.

Also its potential for providing detailed data for school personnel and providing management data for state and federal governments will be limited only by our imaginations. Cooperation of the states, and availability of operational funds. A functional System now exists—the states are making progress in utilizing the System; and I believe the federal government cannot renege on its commitment to this most deserving and disadvantaged group of children of this nation. The support of Congress for the continuation of this vital effort is urgently and sincerely solicited.

It is quite evident that I am a firm believer in technology and how it can enhance the educational welfare of children. However, proper training must be given to the principals and the classroom teachers of the school systems in our nations to achieve the greatest benefits for all students. It is most important for a thorough

understanding so planning guides can be developed for the environment in which microcomputers and other forms of technology are placed. I would suggest to any school administrator that objectives and projections be made along with a strong commitment before embarking upon a venture to insure its success for the administrators, the classroom teachers and students. Technology, in other words, can only be as good as those who use it. I see many benefits in the use of technology in the classroom for all segments of the educational structure.

Mr. BIAGGI. Mr. Murphy.

Mr. MURPHY. Thank you very much, Mr. Chairman.

I don't believe I have any questions, but I did want to thank all of you, each of the witnesses, for answering our request, mine and Mr. Perkins', to be with us this morning. Your testimony will go a long way in helping us build our case for improved technological services in the classroom, which we feel very strongly about. I do appreciate your testimony.

I may have a need for additional information in the future. If I might, I will have our staff contact you and you can provide us with that. As we proceed with these hearings and our concept, we will also keep you advised.

I want to thank the providers of the equipment as well for bringing their sophisticated equipment here. I am anxious to see it in operation.

I yield back the balance of my time, Mr. Chairman. Thank you.

Mr. BIAGGI. Mr. Erdahl.

Mr. ERDAHL. Thank you, Mr. Chairman. I have just a couple observations, and maybe also a couple of questions. Ms. Hakansson and Dr. Fisher cautioned us, to be sure that the computer is utilized as a servant and not a master. I think that is something we need to be well aware of.

But I would like to address a specific question to Dr. Deck, and maybe the rest of you could comment on it if you wish, as well. It seems like, Dr. Deck, you bring up a fundamental area of conflict in the whole area of the Federal Government getting involved in software preparation which, in a sense, implies curriculum development, an area which, historically at least, has been the prerogative of the States and the local school districts.

Do you see areas of potential difficulty there, and also potential resolution of that what I would think is kind of a basic conflict?

Dr. DECK. Thank you for the chance to clarify that, Mr. Erdahl. No, I would not recommend that the Federal presence be responsible for the development of the substance of these programs. Instead, what I had in mind is the nurturing of arrangements of local schools systems with the publishing organizations and other arrangements so that the programs are done as they have been locally, but that the wherewithal to make this feasible and the Federal presence would be to facilitate this happening, not to establish what the substance of the programs would be.

I appreciate the chance to clarify that important difference.

Mr. ERDAHL. Mr. Chairman, I would just follow up a bit on that. You make the comparison, Dr. Deck, similar to publishing houses that might publish textbooks and workbooks and whatnot that respond to order, from local school districts or States for various types of reading or instructional materials. I suppose one could make that transfer of applicability. It seems like, because of the costs involved and the procedure of formulating the programs, it is

going to be very difficult, unless there is some consortium or whatnot of the State and local levels, to agree on the type of course work, curriculum, and so forth.

Maybe that should be more of a challenge and an opportunity than of a problem.

Dr. DECK. I would hope so, Mr. Erdahl. Dr. Fisher alluded to the fact that the production of these kinds of programs are more like the production of a movie than like the production of a textbook, and I think he is quite right. That is why I believe that consortium arrangements offer the expertise of the people in the schools combined with production and marketing expertise of the publishers and with appropriate roles to be worked out and played with other members of a consortium as well.

So, it is a challenge, but I think we are trying to learn to adapt technology in ways we have not heretofore done in the schools, and that these kinds of efforts enable us to learn how to do that, in effect. The proper role, in my view, for Federal assistance is to nurture these efforts to learn how to do it and to meet the challenges in appropriate ways.

Mr. ERDAHL. Mr. Chairman, probably it is no greater challenge to accomplish that than to achieve the appropriation of the Federal funds of the magnitude that you suggested, but I am not saying you shouldn't pursue that as well.

Does any other member of the panel wish to respond to that or any other areas that come to mind as we wind this panel down? Ms. Hakansson?

Ms. HAKANSSON. Thank you.

I think that Dr. Fisher's statements and Dr. Deck's statements are very true. There is a great deal of expense in the development of software. I can tell you that firsthand.

I get a little concerned when I hear about large major efforts of the sort that you are talking about. I don't know the answer. I know that there is the need for large expenditures of funds and there is a need for highly skilled people coming together. Yet, I get concerned when I think about the kind of effort that we give as a standard curriculum, which I think is an outgrowth of what you are asking. If that kind of an effort is put together, how do you avoid that? How many of these can you fund? How do you avoid the issue when you have this done in one area, and is it going to be adopted by default because there aren't competitors in other areas? I get a little concerned when I hear that. I don't think we know enough to do that yet.

I don't like to see it, anyway. I like to see a variety of choices.

Mr. ERDAHL. I appreciate your sharing that.

I saw again, Mr. Chairman, for the record, Dr. Deck was shaking his head and the court reporter can't pick that up. Maybe you would like to verbalize your response.

Dr. DECK. I simply would again argue that the important element here, as I see it, is the involvement of local school systems and the people in those systems to protect against standardization. My argument is based on my experience that, in trying to combine to provide a dozen schools systems with a publishing company, we found that there is wide variety. There are ways to, I think, overcome those efforts that I think we must learn how to do. So while

we are moving through some frontiers with the use of the machines, I think these are frontiers we need to move through not to establish national curricula—I absolutely agree with your concern there—but I believe that that can be overcome in arrangements of the sort that I have suggested.

Mr. MILLER. Mr. Erdahl, I would like to make one comment. I alluded to in my testimony that the directors of migrant education developed skills in reading, math, early childhood, and oral language, not as a curriculum, but as a road map where any other materials could be cross-referenced to that. Forty-eight States did that back in 1969, and today they are developing the courseware and software along those lines.

So I don't think that we are approaching a national curriculum, by any sense of the imagination. We would all be against that.

Mr. FISHER. I hope nothing I said indicated any support for a central Federal software publishing house that is going to put out the curriculum for America. Nothing was further from my thoughts. But that leaves enormous roles that I hoped to have suggested in doing the research necessary for anyone in the private or public sector to produce good software. So there is that research end.

Also, there are a lot of other necessary functions, it would seem to me, to be public. There is the evaluation and follow-on what is good, and thorough testing of what indeed works, and reporting that in an impartial way unrelated to a financial interest. There is the training of manpower that can use this, which has been alluded to, largely teachers.

One can even go further and support software production by putting the sources in the hands of school districts which are free to go where their decisions leave them, but which indeed will serve to increase the output. There is a very large Federal role, it seems to me, although we may rule out a Federal curriculum-writing program.

Mr. ERDAHL. Thank you very much to all of you for those observations.

Thank you, Mr. Chairman.

Mr. BIAGGI. Mr. Kildee.

Mr. KILDEE. I will be brief, Mr. Chairman.

I would like to thank the witnesses. As a former teacher, I recognize that education has to be dynamic since we live in a dynamic society and we have to update our technology to assist the teacher. That doesn't limit the role of the teacher, it enhances the role of the teacher.

As a language teacher, I can recall going through the transition when language labs were being funded and built. There was some concern at that time that labs might limit the role of the teacher. But I found that it really enhanced my role as a teacher and helped in imparting knowledge to my students. So I think in a dynamic world we have to make sure that education remains dynamic.

Thank you for your testimony.

Mr. BIAGGI. Mr. Petri.

Mr. PETRI. Thank you.

I just have one area I would like to explore with Dr. Fisher, if I could, and that is to maybe noodle a little bit about the appropriate Federal role, substantial or insubstantial, however it would be.

It is my impression that it is a huge and powerful change in technology that has occurred and it has overwhelmed the educational establishment in effect, and the establishment has resisted it, basically. That has been the history of companies and institutions that have tried to be in the forefront of this, like Control Data with its PLATO system, and the Federal Government did fund that, along with the University of Illinois and others. There have been thousands of hours of instruction available in that medium. However, it has been hard for them to get contracts, frankly, and people resisted.

It is also true, I think, that we will be selling 1 to 2 million home computers next year in the United States. People will be making millions of dollars in the United States with individuals writing programs for games, and so on. They can rewrite things and do it this way, through films and 1,001 different media. They can copyright that and then sell it. There is a huge market there.

What is the need for this Federal money, if people can sit around their homes and write programs? Do they need a cyclotron? Samuelson made a couple million dollars writing a basic economics textbook. There was no real need for Federal funding for that, or for writing programs that people can sell and use. We want to keep it flexible.

Take your own example, just to conclude and give you a chance, on how people should be told they made a dumb mistake. It might depend on the context and the type of thing they are studying. That is kind of an art and, therefore, a lot of different things ought to be tried, and some will sell and some won't. That will emerge out of the general yeast that will occur. The Federal Government can spend a lot of money, but it is not going to contribute to the yeast particularly. It will occur whether we spend the money or not. That is what I would like you to address.

Mr. FISHER. I think the dynamism of the developing cottage industry in computer software is a great national resource. I don't want to play it down. I think the fact that one can enter and produce small programs and put a little ad in the back of magazines, "$35 and I will send you my program," that is great.

It is not going to produce excellent educational material. It has not done so today, and I have cited the testimony to you. I think you ought to look at that. You will find that you can sell things which are sellable, but which are other than educational. There is no necessary conjunction of those two characteristics in software. We have a public interest in the educational value of the software, and it is the educational value of the software which isn't very good and which may not move sufficiently for the private sector to provide it.

What I have suggested, I think, is that we publicly seek to provide that industry of private enterprise with what they need to do what they can do best. They need to know more about the principles of what works. I think the fact that tutorial intervention might differ, depending on subject matter, is an astute observation with which I agree. That makes the research more complicated and

more extensive. It has to be followed up. Do they remember 2 years from now better from using this method 2 years ago or that method ago? This has to be done over a wide variety of subject matters and a wide variety of different kinds of help which assists them.

It is unlikely that a private enterprise will invest in that, because private enterprise simply is not going to capture for itself the public value in having that information generally available to those who wish in the private sector to go ahead and do computer enterprising.

Mr. BIAGGI. Would the gentleman yield at this point?

Mr. PETRI. Yes.

Mr. BIAGGI. I have listened to Dr. Fisher and all the witnesses.

Mr. FISHER. Not Doctor, it is just Mr. Fisher.

Mr. BIAGGI. Well, we are relieved of that burden.

Mr. PETRI. He is a lawyer, and they changed that title to doctor years ago.

Mr. FISHER. In my day.

Mr. BIAGGI. I share the concerns of Mr. Petri, not so much for the expenditure of the money—and I understand the concern expressed by the witnesses. Mr. Fisher said you weren't talking about a central warehouse for courseware. What is wrong with the concept of establishing a basic segment of courseware that is universally applicable in dealing with regional variances? Isn't it conceivable, with relation to your tutorial segment, that you could develop that part of your program so that it has universal application, or at least regional application? We are not going to tailor this thing down to the finite.

Mr. FISHER. You are correct. I still think there is a rather big research job in developing those principles.

Mr. BIAGGI. OK. Let's pursue it a little bit further. Instead of talking about private enterprise not being there and total Government, what is wrong with the notion of having the Government issuing a grant to some university or some reputable group to develop a model?

Mr. FISHER. I think that is exactly what should be done. I don't mean the Federal Government should have its own paid personnel to do this research. That isn't the pattern generally employed for the best of Federal research. In fact, some excellent research of exactly this sort was indeed going on by the National Science Foundation, research on its science education directorate, which has been eliminated. Fifty million dollars a year is gone.

Mr. BIAGGI. So we are really not talking about inordinate sums of money.

Mr. FISHER. No, sir.

Dr. DECK. You could also make grants, of course, to consortia. That is the thrust of what I am trying to recommend.

Mr. BIAGGI. I understand that.

Mr. Petri.

Mr. PETRI. Thank you.

Maybe just to conclude, I will follow up a little bit on the chairman's questions, too. You say that there are a lot of games and other things that people are doing in the way of computer programing or developing software and that there is a big market for

it, but, in addition to that, that we have, for public policy reasons, some that may not sell as well but that we ought to develop. Therefore, it is a good idea to subsidize those through giving grants to the National Science Foundation or other means to make sure that they are developed, the way we have the Army developing teaching films, for example, but not subsidizing Walt Disney in "Fantasia." They are both useful and they are both going to happen, but the teaching films will not occur as fast if there is not Federal money; is that the point?

Mr. FISHER. Yes, I think that is correct—or some public funds, and I don't see any other good source.

The quality of teaching, how you use this machine for education, we don't know much about that. We talked about how the technology is moving so fast that it is quickly becoming obsolete. In early June, the University of Delaware, a leader in computer-assisted education, had a conference on research issues with computer educators. I came away from that conference and talking to many of the people who delivered the papers there with the sense that we are soon going to have a machine which will do everything. You name it. It is going to talk to you. You are going to talk back. You are going to touch it. It is going to have tremendous memory. It is going to have tremendous power of education. That is going to come. I don't know when, maybe in 10 or 15 years.

But what I will tell you is that if we start now a major effort to use that machine, we will not be ready to use it at maximum power for education at the time the machine is going to be available. What is driving the machine in this country is not educational purposes. We are riding along. We are seeing how we can use this machine.

Mr. PETRI. It is like the printing press when it was developed. Professors, though, still read to the class the way they did before the printing press and books were developed.

Mr. FISHER. But the troubadour technology is still going on at the college at which I teach; you are correct.

Mr. PETRI. In the same area, though, books are written for kids in all levels of education, and I think most of them are done by teachers or by other people, and they make a buck doing it or they are interested in doing it, and they do it for their contribution to humanity. The Government doesn't have to subsidize it. Well, maybe we do, I suppose, and is nice, perhaps, to subsidize it, but I don't think this is really central to that whole process of having printed teaching material available.

Say this machine is developed and a fellow can sit around or a couple people can sit around and develop programs. I agree that there is fantastic machine out there. Why is it that the Federal Government is essential in somehow developing programing for this?

Mr. FISHER. The panelists are anxious to answer.

Ms. HAKANSSON. I agree with you that there has to be the free enterprise system. But I think that what Mr. Fisher is talking about is something slightly different. In producing books, I agree, the books themselves perhaps should be written by individuals for all the reasons that you have given out. However, what we are facing now is we had about 400 to 500 years to adapt to the intro-

duction of the printing press. People learned to read slowly and they learned to use this media in a well-organized, slow and reasoned fashion. We no longer live in those times. We have compressed those 400 years into only a few years.

I think that what Mr. Fisher is talking about with the Federal Government's role is to help us to learn how to use this technology, how to create quality programs. It is interactive. It is not like a book. It is not like a film. It is not a filmstrip. It is not television. It is nothing that we have used before. It is a new intellectual skill that has potential to open up human thinking in a way that it has never been before. It is the only intellectual tool that we have devised since the beginning of the industrial revolution. It is to man's mind what a crane or a lever is to our muscles. We don't understand it. It is totally new.

If we are going to effectively use it, if we are going to begin to use its potential, if we are going to give its power to people, then we need to understand more about how people think and how we can relate that tool to capture and to cultivate the human creativity and how we can allow people to exploit it to its fullest. We don't understand that. That is what we need to understand for us to produce the software.

I agree wholeheartedly that the software itself should be produced by free enterprise. I think that is the role of free enterprise. I am in it. That is why I am there. But I do believe that we need help. I can't afford to sponsor all of the research that is needed to understand how these children are relating to this instrument. That is where we need the help.

Dr. DECK. I just want to reemphasize that, if I might, sir, that it is new, it is different, and we have to learn how to use it. But I think we have to take advantage of the indigenous understandings in the schools in the development of this so that we get quality. I think that is the key. The quality will come not just out of the market availability, but out of efforts that are based in research.

Mr. PETRI. I have just one very last question.

Conceded it is new and it is different and we have to learn how to use it, would it be best to operate through, in your opinion, the Education Department or some sort of line of the Federal bureaucracy or, instead, through private and public or essentially eleemosynary foundations in giving grants, rather than attempting to have lots of people sitting in offices shuffling papers back and forth attempting to grapple with this new machine?

Mr. FISHER. I am not critical of the form in which the research of the National Science Foundation takes place. I think it is a good model. I think it has been effective. I think we have learned a lot about how to use our public resources for research without tainting results, with engaging the best minds of the country wherever they are located. I think the Federal Government knows how to do that. It is just that they need to put this item on that agenda. I think the committee ought to ask the National Science Foundation and ask the Department of Education what they think of this report that you have received this morning. You ought to ask them to come back fairly soon to tell you what they are doing about the questions raised so that you can proceed to formulate, with whatever help you want to have, by further hearings, your agenda for

some action. There have been an awful lot of reports about the subject.

Mr. BIAGGI. I thank the witnesses very much for their valuable testimony. The points have been clearly made. Development is going to be, I think, long and fully implemented. At the outset, there will be some cost; but in the end, I think, free enterprise will take over.

Thank you very much.

The formal part of the meeting will terminate, but we have a number of demonstrations here and the members are invited to leave the rostrum and go to the various instruments in this order: Apple Computer, Rita Kohari, No. 1, Texas Instruments, Herb Ruttledge, No. 2, No. 3, Control Data Corp., Denis Eichhorn and Janie Erickson; No. 4, U.S. Army Signal Center, Dr. Ketner; and the American Heart Association, David Hon.

The meeting is adjourned.

[Whereupon, at 11:10 a.m., the subcommittee was adjourned.]

[Material submitted for inclusion in the record follows:]

PREPARED STATEMENT OF RETA KOHARI, REGIONAL EDUCATION SPECIALIST, APPLE COMPUTER, INC., CHARLOTTE, N.C.

Over one million personal computers are at work today and the number is expected to increase fivefold by 1985. Microcomputers have transformed the connection between people and computers—creating a productive, interactive one-on-one partnership.

The personal computer delivers power where and when it is needed—only it is a different type of power—the kind that provides quick access to vast amounts of information, instant data processing, and intelligent solutions to a wide range of problems.

Personal computers, previously thought of as expensive gadgets, are changing forever the way we work, learn, and communicate.

Then, what will be the demand for computers in the educational industry? First, consider the number of students in American who own pocket calculators. In this decade we will see calculators and computers changing the nature of the educational system in numerous ways.

The personal computer is becoming more directed toward the educational process and will be more attractive to prospective buyers. People who can afford a personal computer for their home must be able to justify the cost; therefore, one function to be considered is its teaching capability and value to the children in the home. This affordability of personal computers for the home as well as small businesses will increase the numbers available and will lead to major changes in the educational process itself.

The development of portable computers will come about as a necessity of providing students and teachers with more advanced learning tools. Once the technology has advanced to allow for mass production of the compact units, then manufacturers will be able to offer the units at a reduced cost to the consumer.

This change in the industry will allow the technology to become widespread and more readily accessible to people of all economic classes. Computers are rapidly becoming a part of our lifestyle and are not going away. Educators will find it necessary to face this fact and decide how to meet the challenge that lies ahead: Computer literacy for everyone.

With this in mind, how do educators begin to use this powerful tool? The flexibility of purposes and applications is limitless. Availability of programs must become extensive enough to handle all needs for which computers are designed to serve. At the end of 1981, more educational programs had been written for the Apple Computer than any other computer on the market.

Computers which teach and are so called "smart" will adjust their responses and interact to a degree with their partner at the time. This type of interaction is more similar to that which man is accustomed. One aspect of this type of technology is not always immediately evident: It is far less difficult to develop the technology capable of providing this interaction than it is to develop the methods of providing the accompanying effective teaching materials.

Certain features which add to a more lifelike means of communication are already available. Many computers can be equipped with voice capability through speech synthesis at a low cost. Computers which recognize human speech and will be used to assist in speech problems are probably not going to be available until around 1990. Conversations with these "smart" computers will be taking place after that time. Developments in artificial intelligence will determine that availability.

All of this means that educators of today must be visionaries. They must be able to accept the challenge and threats posed by the computers in the preparation of their students for the future. They must understand what impact this technology will have on the methods used in their classrooms. They must be motivated to add on to an already exhausting list of responsibilities, countless hours of learning about the technology themselves.

The logical approach to this situation would be the establishment of an educationally sound and governmentally approved computer curriculum. However, the amount of time required for this monumental task is not available.

Another consideration to be placed on the educator's shoulders is the ramification of the computer's degree of penetration. We are creating another division of the haves and have-nots. Again, consider the history of the calculator. The child in the educationally and culturally rich home who is exposed to the calculator will experiment, for sheer enjoyment, with all its functions, thus becoming equipped with more skills than one who is less fortunate.

Math teachers are familiar with the student who has aquired an intuitive grasp of fundamental mathematics, as he/she stands out from the rest of the class.

This kind of elitism is even more marked in schools where computers are available. Sharper divisions are occurring as the first teaching computers come on the market. Some children latch on to them with eagerness, while others ignore them completely.

If the trend continues, we may find that we have created a generation of children sharply divided. Some will have magnified their own brain power with the use of the computer, while others will remain behind in the past.

The problem may seem unsolvable. There are always those who seize the gifts that society offers and those who, from either ignorance or lack of motivation, reject them.

The National Education Association's Special Committee on Instructional Technology reports "the current impact of new technology on instruction gives increasing impetus to the prospect of a full-blown, universal system of instructional technology."

Sharon Robinson, Director of NEA Instruction and Professional Development, believes that a technology of instruction may be imposed from outside by commercial interests.

The future direction of the educational profession may very well depend on teachers' abilities to master the technology and know what it can and cannot do, and recognize the essential attributes that they will be providing as well as instruction in technology. The National Education Association Special Committee on Instructional Technology stresses the following:

"The role and influence of teachers in shaping the future of education in a technological society will depend on the ability of the teaching profession to anticipate, plan for, and give direction to such change."

The Rockefeller Foundation's Commission on Humanities describes the situation in "The Humanities in American Life" report this way:

"Computer literacy must now be considered among the goals of a liberal education by all colleges and universities, the training of undergraduates in the use of computers should include consideration of the social repercussions of informational technologies. . . . Liberal education must define scientific literacy as no less important a characteristic of the educated person than reading and writing."

Educators must become proactive rather than reactive in developing the relationship between education and the rest of society. Considered in the plans for action should be the best available projections on the labor force and the job market.

In about 1960 the U.S. birthrate began to decline. Consequently, in the 1980's the labor force, which draws most of its new workers from among people aged 16 to 24 is likely to grow more slowly. Also, the proportion of workers who are aged 16 to 24 will decline from 24 percent of the total to 19 percent.

In general, growth will continue to be more rapid in industries that produce services than in those that produce goods. It is predicted that among the service-producing industries, the sector called services will continue to grow fastest, mainly because of projected rapid gains in industries that provide health care services.

Among the goods-producing industries, manufacturing is expected to pick up during the 80's primarily because of anticipated strong demand for durable goods such as computers and other high technology items.

Since the economy is expected to generate fewer new jobs in the 1980's than during the previous decade, one major implication is accentuated even though the lowered number of young workers will experience less competition for entry-level positions. Employers will be raising their entry-level requirements as jobs become more complex.

Preparing a nation's future workforce is a tremendous undertaking. With the incorporation of computer technology into the curriculum, the teacher will ultimately become more of a professional—a consultant to his/her students by analyzing the needs, prescribing certain materials, and evaluating the individual's learning progress.

Apple Computer is actively looking for ways to facilitate the use of computers in the education market. Providing computers that are both friendly and easy to operate is one of our corporate goals. This feature of the Apple was one of the many reasons the State of Minnesota decided on it as the standard educational computer system. We will constantly be striving to achieve and maintain the high level of customer satisfaction which we currently enjoy.

Recognizing that our primary area of expertise is hardware, we must rely on the educational publishers and educators themselves to develop and produce educationally sound software programs. Through these programs, students are becoming involved in drill and practice, simulations, gaming, and programming designed to teach concepts or to expand students' knowledge levels.

We, at Apple, understand the budgetary restraints imposed upon the educational agencies throughout the nation. Therefore, we have signed numerous state contracts which enable teachers to acquire Apples at substantial savings. Beyond the initial purchases, though, is the need for the instructional software. Many of the states which buy under the statewide agreements are setting up regional centers to serve as clearinghouses and points for software evaluation. For example, in Raleigh, North Carolina, the Materials Review and Evaluation Center, a division of the Department of Public Instruction, is a resource for educators to preview any programs which they are contemplating for purchase. By having access to these materials, North Carolina teachers are saving money by investigating evaluations written by other professionals throughout the state.

Apple Computer is dedicated to providing the service and support required by educational users of the computer. Grants are available from the Apple Education Foundation for those professionals involved in software development. Examples of services provided are the resources in the form of workshops and training offered by the dealer network in connection with education representatives located across the country. Literature is published by Apple to keep educators abreast of current events and uses of Apples in education. One of the most frequently requested publications is the Journal of Courseware Review which contains software reviews written by educational professionals.

Resources:

Annual Report, Apple Computer, 1981.

Questions for Teachers, Sharon P. Robinson, *Today's Education*, April-May, 1982.

The Micro Millennium, Christopher Evans, Viking Press, 1979.

"The 1995 Labor Force: A First Look," Howard N. Fullerton, Jr., Monthly Labor Review, December, 1980.

"The U.S. Economy in 1990," selected articles, Monthly Labor Review, August, 1981.

PREPARED STATEMENT OF JOHN LIPKIN, BUREAU OF SOCIAL SCIENCE RESEARCH, INC., WASHINGTON, D.C.

At the risk of being considered a pessimist with respect to technology, I would like to inject some sobering views and findings regarding technology's impact on education. For the past nine months, I have been considering the issue of equity as it relates to microcomputer use in education, and what I have found is cause for serious concern.

It should be made explicit that although my observations and judgments are based on the best available evidence, they are clearly lacking in the necessary social scientific support which is required for the formulation of the policy or programs required to effectively address the equity issue.

Five years ago the charge was put forward to Congress to study and plan for the psychological, sociological and political implications of computer technology in a comprehensive manner (Computers and the Learning Society, 1978). This charge has gone unheeded, and today the need for research to determine the educational and social consequences and possibilities of microcomputer use in education is more compelling than ever.

If by equity, we mean a fair share of any public services that are required, then we would expect the public schools to provide instruction in a manner which does not favor particular geographical areas or groups or individuals.

Unfortunately, there is a clear pattern of inequity in the distribution and use of microcomputers in the American public education. The persistence of disparities in the provision of educational services within and between states and localities and the propensity of the affluent members of society to gain prior access to and benefits from technology militate against equitable technological education in the public schools.

In general, the more wealth a school district has, the more likely it is to utilize computers in the schools for instructional purposes. An analysis of a national data base conducted by Litigation Suport Services further revealed that schools with a high concentration of minority students and schools in rural areas were less likely to have microcomputers than their suburban or urban counterparts or schools with small percentages of minority group students. In spite of the public school's historical commitment to equality and the society's efforts to advance this principle, particularly during the past three decades, the basic framework for providing equity in public education has not been achieved.

It would seem that the wealthier members of society are the first to perceive the benefits of microcomputer education; improved educational quality and preparation for higher education and higher paid computer related occupations. Furthermore, they have the means to provide themselves and their children with these benefits. An examination of the patterns of microcomputer use for educational purposes suggests that the affluent families first used it in their homes during the late 1970's and then turned to both public and private schools for microcomputer instruction.

Not only is there disparity in access to microcomputer use between the rich and the poor, but there is a difference in the use made of the microcomputer as well. At the elementary level, it is the urban, low-income minority student who is more likely to be provided with drill and practice usage of the computers, while the more affluent students use it for more creative purposes, related to problem-solving and discovery. At the secondary level, an analogous dichotomy is beginning to emerge. Low income, inner-city youth are being offered vocational programs designed to furnish word processors, data processors, or computer repair persons to local businesses who frequently are called upon or who volunteer their assistance in the establishment and implementation of such programs. This is in sharp contrast to the higher level uses of the computer which pertains to the more affluent college bound youth.

By way of summary, there is an apparent bias in favor of the higher income students in microcomputer use for educational purposes. This bias results in a much greater likelihood that the child from higher income families will receive the benefits of microcomputer education in the home and the school. When the children of low income, minority parents do come into contact with the microcomputer in the schools, the use is likely to be of a different kind and lower intellectual order than that experienced by more affluent students.

As we have indicated, the problem of inequality in education is neither new, nor peculiar to the Information Age, but it does appear that the microcomputer has the effect of exacerbating the problem and causing it to stand out in sharp relief.

On a more optimistic note, the urgency and the clarity of the problem help in identifying a solution or, more correctly, a direction for the public schools to take in meeting the challenge posed by microelectronic technology.

It has been suggested that computing represents a new system for orgnizing and transmitting information which is becoming as essential for learning and communicating in today's modern society as reading and writing have been from the time of the Industrial Revolution. If computer literacy is, indeed, an imperative of the modern age as many government officials, computers scientists and educators have said, and if it is best taught in a hierarchical fashion to students beginning at an elementary level, then it is to the public schools which we must turn for the resolution of the problem of achieving universal computer literacy in an equitable manner.

Following the lead of such contemporary architects of education as Patricia Graham, David Moursund and Seymour Papert, computer literacy would take its place in the school curriculum for all students. Instruction in computer literacy

could serve as a bridge between the existing subject matter, including the basic skills of reading, writing and mathematics, and the development of reasoning power and problem-solving abilities, thus reconciling the dichotomy between students of different social backgrounds, discussed above.

When the potential benefits of universal computer literacy are considered, or, conversely, when the negative consequences in societal and individual terms of a nation in which some are computer literate and some are not are considered, the task will become clear. It should be recognized that it is a long, costly and arduous one.

[From Biomedical Communications, Sept. 1981]

Computer and Videodisc: A New Way to Teach CPR

By Lynn Hessinger

Cardio-pulmonary resuscitation, or CPR, will soon be taught from the "victim's" point of view, using a new, interactive, videodisc system. Developed by David Hon of the American Heart Association, it incorporates all past forms of CPR instruction—manikin exercises, instructor evaluation, theory and testing into a new concept: a totally self-contained instructional unit. The interactive system includes a Sony VDP-1000 laser optical videodisc player, a monitor, an Apple II computer and a random access audio machine. At the "heart" of the system is a Laerdal manikin, wired with an array of sensors placed at key points in its lung system which monitor the depth and placement of CPR compressions. As the trainee practices these compressions, he or she receives several different types of feedback: audiovisual "coaching" from the doctor on the screen; a visual readout on the computer monitor indicating, for instance, that hand placement is too high or depth is too shallow; audio tones to indicate proper timing of each compression; and, finally, a graphic pattern on the computer detailing overall performance.

During a typical learning situation, the student begins training by viewing a videodisc introduction by a doctor, who presents classroom background. Various videodisc freeze frame segments are included in this section, showing graphics of body locations integral to CPR. The random access audio machine provides accompanying narration, easily circumventing the fact that sound during a freeze frame is not possible. The doctor, working in conjunction with the Apple II computer and the random access unit, guides the student through the knowledge requirements and psychomotor skills needed to perform CPR.

At various points during the program, the computer asks evaluative questions in "fill-in" or multiple choice format, and displays a word or alphabet template. Using a light pen, the viewer "answers" the questions by touching the pen to the appropriate words or letters to "spell out" his response. The computer then evaluates key letter combinations, even allowing for misspellings. An advantage to using the light pen is that it eliminates the need for keyboard typing skills.

The computer monitors and displays student progress throughout the course, accessing video segments for review and detailed explanations when necessary (such as when a viewer responds to a question incorrectly). At any time during the instructional part of the program, the student can call up a "menu" offering various options to choose. For example, he can take a break and stop the program (temporarily or permanently), restart from where he left off after that pause, review some material, request to be tested and more. Another option available is access to a vocabulary dictionary consisting of approximately 200 still video frames. This word bank allows the learner to define unfamiliar concepts or to receive technical information. It is available on three levels, for beginning, intermediate and advanced (technically inclined) pupils.

Lynn Hessinger is an interactive video consultant based in Stamford, CT.

David Hon receives instructions from the doctor on screen.

A compression being performed on the manikin.

After the instructional segment of the program is completed, the student is ready for evaluation. In this section, the same methods used to evaluate technique during the instructional segment are employed to monitor the student's final "hands on" performance for certification, which lasts approximately one half hour.

In fact, the entire process takes no more than a few hours. Time estimates for initial certification are an average of two hours for a one-person course and four hours for a four-person course (two learning hours and one half hour each for individual evaluation). Six month recertification should take approximately one half hour per person; recertification after one year requires about one hour per person. The time condensation is the result of two factors: the high degree of interactivity which tailors the learning situation to exactly fit the needs of each individual and the natural condensation which media training generally achieves.

Why videodisc rather than videotape? The disc allows for faster access to various video segments, which is particularly important during actual compression training on the manikin. Due to this feature, a student can receive almost instantaneous feedback (in the form of "coaching") by the doctor on the screen, almost as though the doctor is there in the room. The disc allows fast as well as infinite branching of these 10 or 20 second segments, creating a high degree of interactivity. For example, the compression coaching can literally go on all day, with the computer accessing comments appropriate for each compression performed.

Lectures, handbooks, manuals, manikin exercises, slides and films are currently used in CPR training. Any single type or combination of these methods necessitates a classroom, instructors, student registration and course scheduling. Meeting the CPR standards set by the *Journal of the American Medical Association* is also a major consideration. All training factors and requirements become very costly and difficult for any community to maintain, regardless of its size.

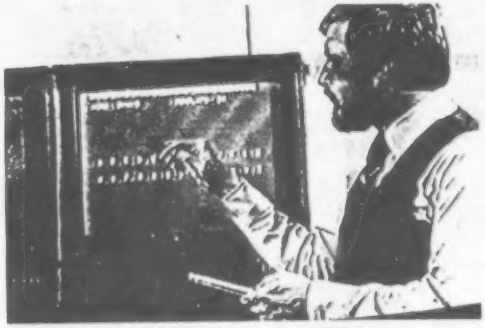
Hon's CPR system is designed as a complete, self-contained unit which can be sent into the field to instruct and present information with "hands on" manikin experience, to certify learner skills and provide refresher courses and evaluation for recertification. In addition, the American Heart Association sees the system as having the following benefits:

- *A high rate of participation.* The system is designed to accommodate up to four persons per course/session. All four students work off one system and receive the learning material as a group. Then, using the same system, they receive individual evaluation in order to be certified.

The Heart Association estimates that one system could recertify up to 2000 trainees per year. Total initial certification would yield somewhat less, but the system can be used for more than one learner per course.

- *Standardized accreditation and recertifications.* The system provides a standardized evaluation for each individual registered in a CPR course, and is available to new learners as well as those previously trained.
- *Reduced personnel requirements.* Since the system is self-contained, the three to five instructors usually required for each class are unnecessary. If desired, one instructor may be available to answer further questions and/or comments. The computer maintains student progress records, thus eliminating most testing and administrative paperwork.
- *Learner benefits.* The interactive system's "total coaching loop" accelerates learning through immediate feedback and evaluation, with the opportunity to review any procedures, view new instructions along with diagrams and simulations and practice compressions. In effect, the student takes only as much time as is necessary, with the option to take the course at any time during a 24-hour day.

The system is now in its final development stage, with a major marketer still to be selected. [redacted]. The Association's goal is to increase the number of people certified in standardized CPR. Delivered "by the victim," this interactive course builds upon established training methods, but enhances learning, making it more interesting, more objective and, after initial investment, reducing training costs and learning time.



Questions are answered by spelling out words on the template.

Evaluative data appears on the screen detailing overall performance.

Note: The videodisc, including motion, photographic stills and medical illustrations, was produced by Jane Sallis, Dallas-based medical illustrators include Edmond S. Alexander, Eugene New, Maura Flynn and Cindy Turner. Machine-language programming was done by Bob Sander-Cederlof.

[From Health Care Education, June/July 1981]

The Videodisc to Teach CPR

"Interactive Video: What's It Mean to the Trainer of the 80's?" was one of several concurrent sessions presented at the Sheraton Boston, May 17-22, during the ASTD Conference and Exposition.

It would be hard to imagine a more effective presentation of the Sony Interactive Video System than was produced by David Hon, national training manager of the American Heart Association.

David took the hardware, saw what it could do, created a learning program for it, and extended the use of the hardware itself—all in all a formidable accomplishment. The idea is not really new, and those who date back to the Talking Typewriter furor in the 1950s will concede that having a learning tool talk was reduced to practice earlier. But Mr. Hon places the idea squarely in 1981, and his route to this kind of feedback is unique. He says—and quite properly—that it's hard to put into words the things he does. But while the system is its best advertisement or explanation, we'll give words a shot here.

The problem is that CPR (cardiopulmonary resuscitation) instructors are in short supply—when you consider that about 1000 persons die daily as the result of failure to get such help quickly. The instructors have to teach a great many people, and burn out. They must be requalified periodically. The self-paced learning set-up which Mr. Hon has devised for the Heart Association consists basically of a videodisc player, two monitors, a student responder (keyboard and wand) and a manikin. The left monitor shows a doctor figure who walks you through the program—with its many branches and turnings. The right hand monitor delivers computer generated feedback in a variety of ways. The manikin rigged with a lot of switches, primarily borrowed from the burglar alarm field, which tell the computer how deep chest compressions are being made—if the ventilation is effective—things like that. Success or failure with the manikin thus is fed back almost instantly to the student.

The entire program—which must have been murderously difficult to devise--runs two and a half hours, and is derived from a 30-minute video disc. The disparity results because the program is delivered in still-frame form. It theoretically would be possible to deliver a 400 hour program from the same 30 minute disc, were one to limit the program to still frame.

There is simple branching "Yes, I want to learn this. No, I don't want to learn this" and a rather complex menu display. If the student gets into trouble, it's possible to call up the menu. It's much like the bank auto-teller display: "Do you want to make a deposit, or check your balance or get cash . . ." There are nine options, including "I'm going on a break." The program also contains a fairly lengthy "dictionary." If any word is unfamiliar, the learner can call up that word and an explanation of it.

Perhaps Mr. Hon is right—and no sensible explanation of what he does can be given in print. At the most, this description should head you either toward a more complete explanation of it, or avoidance. The temptation to avoid is strong, because Mr. Hon's solution to CPR training signals future hard work for trainers of an unusual stamp. As Mark Heyer of Sony said, the future belongs to trainers who meld the talents of instructional design, video production and computer programming. This has not always been a comfortable mix—and the clear winners will be successful one-man bands who can do all of it

[From Video User, August 1981]

VIDEO USER

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MIXTURE OF PICTURES: A new interactive training program designed to teach cardiopulmonary resuscitation skills, through dramatic, as pictured above, from real footage on effectiveness to help explain certain aspects of that life saving procedure. Transferred from video tape to a laser optical video disc, these frames can be viewed as real time or as still frames.

Unique interactive training system designed to save time, money, lives

by Robert Rathbun

DALLAS, TX — An experimental interactive video training program, produced here by the American Heart Association as part of an effort to increase public awareness of a life sustaining procedure for heart attack victims, will undergo extensive evaluation this month and may be on the market as early as November.

Designed for use with a special playback system incorporating a laser optical video disc player, two monitors, a microcomputer, a random access audio tape player, a light pen, and two microprocessors with built-in sensory devices, the program has been created to provide detailed instruction and hands-on training for persons learning cardiopulmonary resuscitation (CPR). And according to a spokesman for the heart association, both the program and the playback system, which are expected to be marketed as a package less than one year on technologically advanced, "does should increase the effectiveness of CPR training beyond the levels obtained through conventional educational methods."

Simply stated, the purpose of this interactive program is to increase the knowledge and ability of the American [illegible] (AHA) to recognize victims of CPR, a method developed to [illegible] victims [illegible] and to apply [illegible].

[illegible] the same they are [illegible] and the same they use [illegible] medical situations. The procedure although [illegible] those persons to [illegible] requires a certain level of training and proficiency. Until now, however, the only way training and practice could be obtained was through a six hour lecture and demonstration course conducted by a qualified instructor.

Approach: the AHA sets of the video disc, with its random access, multiple branching, still frame, and computer controllable functions, an opportunity to eliminate the need for live instruction, while providing uniformly top-quality training that is both effective and highly accessible.

The brainchild of David Hon, the AHA's [illegible] manager, the

Continued on page 6

McDonnell Douglas Corp. buys ARDEV Co., disc technology

ST. LOUIS, MO — McDonnell Douglas Corp. announced here last month that it has acquired the assets of ARDEV Co., Inc., the Palo Alto, CA-

News Follow-up

based subsidiary of Atlantic Richfield Co. (ARCO) that has developed an optical video disc system.

As reported earlier (VIDEO USER, April 1981), the ARDEV system, which uses photographic film-based discs, is "one generation away from the finished design." However, manufacturing and marketing plans could not proceed until ARDEV's [illegible] sale was completed.

According to a spokesman for McDonnell Douglas, the price paid for ARDEV was "slightly more than $2 million in cash plus royalties based on future selected product sales." ARDEV becomes the video disc division of McDonnell Douglas Electronics Co. (St. Charles, MO), but will remain in Palo Alto with personnel kept intact under the continued management of Dr. Peter G. Wolfstieg.

"One of the applications of the video disc technology is in interactive training," said C.P. Pickard, vice president for finance at McDonnell Douglas Electronics Co., "and that [illegible] area.

Continued on page 11

Nonbroadcast production: should you shoot on film?

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Interactive system teaches CPR....

Continued from page 1

product took more than a year of planning and development and actual production required nearly five months. The program used originally mastered on 1-in. video tape before being transferred to video disc last month at Sony's disc pressing plant in Japan. Includes what Hon describes as "every aspect of CPR training we could think of." The program is extremely flexible: he added, to accommodate both beginners and students already familiar with the CPR procedure.

The playback system itself, expected to sell for between [redacted] and [redacted] when initially available, has been designed to provide students with the opportunity to learn CPR practice what they have learned and receive evaluation on their ability to administer the technique.

As with most interactive video systems, this one has been created in such a way that along with providing information, it will also ask questions and elicit responses from the student. One monitor shows the training material, while the other displays questions and answer choices. A light pen is used by the student to mark his or her responses directly on the second monitor's screen. The microcomputer hooked into the system then checks the student's answer. Correct responses trigger the computer to continue with the program, possibly branching to other sections. Incorrect answers cause the computer to reexplain the material just covered.

Audio adds to the flexibility

Information is presented both in linear formats and via still frames with accompanying audio from a separate audio tape player. This audio deck, offering random access capabilities through the use of a control track and three separate audio tracks, adds to the flexibility and branching functions of the entire program. It also enables the video disc program, with a real time capacity of one hour, to accommodate two and one-half hours of material.

Electronic dummies are unique

Another aspect of the system that Hon pointed out to be unique is the inclusion of two mannequins — one resembling an adult, the other a child — that are outfitted with special pressure sensors. When a student practices on the electronic dummies, the sensors send information to the computer to gauge whether or not the student is properly administering CPR to the simulated heart attack victim. If the procedure is being performed incorrectly, the computer will determine the problem and access a segment on the video disc, usually a still frame with accompanying sound track, that explains the problem and gives the correct procedure. The student then continues practicing, continually receiving computerized evaluation, until he or she has mastered all aspects of CPR.

"The hardest part of this entire project," Hon told VIDEO USER in a recent interview, "was determining everything that a student might do wrong and including it in the program. There's a lot that can go wrong."

Hon explained that this system, once it is out in the field being used, should prove to be much more effective for training than conventional methods. "Using live instructors to administer CPR training can work well," he said, "but it isn't always efficient. Qualified instructors are sometimes hard to find and it's often time consuming and inconvenient to get a group of people together to conduct a CPR training course. And in some cases, he added, using live instructors can lead to a deterioration in the quality of the training. "Some instructors are just not as good as others."

Hon said the interactive system, while providing comprehensive training material in a flexible manner to accommodate any student, also ensures a uniformity of information and eliminates the problem of incomplete instruction.

In addition to Hon, those who worked on the project included Jane Sallis, a Dallas-based independent video producer, various technicians and production people, and a free-lance computer programmer. All material was shot on 1-in. tape using a number of local production houses in and around the Dallas area. Some technical assistance and some video disc players, as well as the mastering and pressing of ten trial discs, was provided by Sony.

Throughout August and September, Hon said, the system will undergo an evaluation process at selected locations around the country. At that time any problems, flaws or bugs found in the system will be corrected. According to Sallis, who says it's possible for preparing much of the material used in the program, the system is flexible enough to allow for the inclusion or deletion of information even after the discs have been pressed. By changing the computer program or some of the separate audio tracks, the material can be tailored to meet most needs.

Although Hon expects the system initially to be offered for sale in the [redacted] range, he noted that high quantity sales and declining hardware costs could lower the price to around [redacted]. The AIEA is currently negotiating with an outside sales representative to market the system nationwide. Potential customers include hospitals, police departments, the military, fire departments, schools, community organizations and corporations.

Additional programs could be developed for the system in the future, added, if the need arises and the demand is great enough. For now, however, he is attempting to get the CPR program out to the public. The greater the understanding of CPR, the better it is for everyone, he said. "If more people know how to administer CPR, it could save thousands of lives each year."

Exxon offers first grant for new AIT video series

BLOOMINGTON, IN — The Exxon Education Foundation has announced it will donate $100,000 to the Agency for Instructional Television (AIT) as partial support for the creation of a new arts education series to be used in public schools in the United States and Canada beginning in 1983.

According to a spokesman for AIT, the series will cover elementary principles and basic concepts of visual arts, dance, music, and theatre. Tentatively called "Television Primer in the Arts," the series will include 26 15-minute programs and corresponding printed material.

Education agencies in the United States and Canada will pool their efforts and financial resources to develop the $3.6 million project under the management of AIT, a nonprofit American-Canadian organization. These agencies will provide $1 million to fund content development of the arts series. Corporations, foundations and the federal government will be asked to give $2.6 million for production and implementation costs.

The arts series is the fourteenth project to be developed under this cooperative system and the third for which substantial business support has been sought.

ITVA expanding to Orient with new Japanese chapter

Following an organizational meeting held in Tokyo last month, under the auspices of Sony Corp., Japan's entrance into the International Television Association (ITVA) appears imminent, according to Al Bond, past chairman of the ITVA board.

At that meeting, Bond addressed more than 400 Japanese nontheatrical video users in an effort to formally initiate the procedure to allow Japan to affiliate with the ITVA. He was accompanied on his mission by Jan Winter, ITVA director of international development, who also addressed the standing-room-only crowd.

"It was a rousing success," Bond commented to VIDEO USER upon returning to the United States. He said he foresees that all necessary procedural papers will be completed shortly and a Japanese chapter could officially join the association, at its early fall.

Although many Westerners are familiar with the video hardware being developed and manufactured in Japan, few persons outside Japan are aware of what the Japanese industrial users are doing with video. Bond, after viewing several sample tapes at the organizational meeting, reported that "some of it is very similar to what we're doing and some of it is new and very exciting. He noted in particular one Japanese company — similar to Federal Express — that produces four news programs each week. All middle and upper level employees of the company have video playback capabilities both at home and at work.

Should Japan become affiliated with the ITVA, the association will be forced to face a new problem. "Virtually all other international affiliates are English-speaking," Bond said, but he added the Japanese industrial users "desperately want to communicate with their Western counterparts."

Other countries currently considering international affiliation with the ITVA include France, Italy, Germany and Switzerland.

events

August 6-7: Software courseware conference to be held by the National Audio Visual Association's Materials Council. The conference will be held at the Sheraton Inn at the Memphis, TN International Airport. For more information call 703-273-7200.

September 4-13: International Audio and Video Fair Berlin 1981. Exhibition Grounds, Berlin.

October 4-9: Institute for Effective Communications, sponsored by the National Audio-Visual Association at the University of Indiana, Bloomington, IN. For information contact NAVA at 3150 Spring St., Fairfax, VA 22031, 703-273-7200.

October 12-14: 1981 fall conference of the Audio Visual Management Association (AVMA) will be held in St. Charles, IL. For information contact AVMA at Box 621, Royal Oak, MI 48068.

October 20-22: 1981 Video Expo New York will be held at Madison Square Garden in New York City. For information contact show management at Knowledge Industry Publications, Inc. at 701 Westchester Ave., White Plains, NY 10604.

October 22-24: 1981 Athens Video Festival at the Video Space in Athens, Ohio. For information, write festival organizers at Box 388, Athens, OH 45701.

November 11-13: 24th annual International Film and TV Festival of New York. For information, write International Film & TV Festival of New York, 251 W. 57 St., New York, NY 10019.

[Reprinted from "Videodisc News" February 1981]

NAVA Notes

It was quite apparent at the National Audio-Visual Association Convention, held in Dallas in mid-January, that videodiscs have truly arrived. The most popular certification seminar was entitled "Videodisc, Definitions, Applications, and Impact on the AV/TV Market." It was coordinated by Daniel P. Gibbons C.M.S. and featured Dr. Harvey Long of DiscoVision Associates, Dan Harris of Sony, and Rex Allen of Cooney Productions. The seminar was so popular that after the initial two sessions were conducted, a third had to be scheduled to meet the demand.

The convention was attended by over 7,000 A/V professionals and was chosen by Sony as the opportune event for the debut of its production model Laser VideoDisc player. Also, in conjunction with the Sony presentation, David Hon, National Training Manager for the American Heart Association, gave the first public demonstration of his CPR training system utilizing a Sony player. This system certainly highlighted the enormous potential for interactive videodisc in training and education.

While the videodisc seminar, the Sony player and the CPR application are all covered in detail in subsequent articles, a few additional comments on the CPR application are warranted.

David Hon has observed that this application evolved from the bottom up. The need for a cost effective delivery system for CPR training was identified, the problem was analyzed and a possible solution was formulated. Then the technology was approached from the standpoint of getting a delivery system to do what the proposed solution called for. This is contrasted by David with the *top down* approach, whereby one looks first at the technology, finds what it can do, and then looks for a means of solving the problem with that capability. He credits this *bottom up* approach with leading to many innovations that may result in as many as six patents.

A second observation of David's deals with the difficulty in marketing this new technology. We have all observed the *chicken and egg* situation that has impacted both player sales and program development in the industrial and institutional markets. David feels that even a stand alone system such as his may not be the key to the problem. In his opinion, the answer may lie in showing a potential customer what you have in hand and then being able to point out a substantial number of projects that are in progress and the results of which will also appeal to the same buyer.

While many companies are understandably reluctant to divulge specific information about certain projects, a more general awareness of the breadth of projects that are being pursued could well be a positive step toward wider market penetration for videodisc technology. *Videodisc News* will both continue its own efforts and support the efforts of others toward that goal.

Interactive Video Disc With Microcomputer and Manikin

There may be a way to save a lot of the lives we now lose to heart attacks. A system in development by the American Heart Association looks like it just may work. And it brings out a new element in the vast potential of the video disc—*coaching*.

Statistics reveal every other person in the United States dies of a heart or blood vessel disease. Of those, three hundred and fifty thousand people who die each year of heart attacks do not make it to emergency care. Often scant minutes, even seconds, stand grimly between life departing and help arriving. In many cases, cardiopulmonary resuscitation or CPR is the only way to sustain a victim's life in that vital time when the heart stops and emergency care is still on its way.

Through the teaching of CPR, thousands of lives have been saved, many by non-medical rescuers—lay people on the spot who knew what to do to keep the heart and the lungs of a victim going until help arrived. But a true outreach of live CPR training classes to a substantial portion of the population could tax even the largest and wealthiest of organizations, let alone community based organizations such as now teach CPR as regularly as they can.

The American Heart Association, which pioneered CPR and sets the medical standards for all emergency cardiac care, may now have found a way to achieve that massive outreach of CPR using the video disc within a learning system it has a patent pending on. At the same time more people are being taught, the system would allow organizations to increase programs without increasing their numbers of live instructors, while maintaining absolute standards and instructions. The stand alone system ties a learning theory based on performance, immediate response, and feedback, into a complete coalescent interaction of students and content. The truly new feature of the system is that now the hands-on performance is taught by the "victim". A manikin which is normally used in instructing live classes, has been wired with an array of sensors to give precise feedback to an Apple II computer. From the evaluation of performance, a proper "coaching" response is elicited from the video disc, and the student can immediately adjust performance. The coaching of performance is elicited immediately as the "victim" responds, in microseconds, and that instant looping causes performance to become more and more precise. This feature, based on sensory peripherals which interact in a complete "coaching" loop, is the nucleus of the patent.

Other design features of the system, as demonstrated and shown in a working disc program to a select group at the American Heart Association Scientific Sessions and to the National Audio-Visual Association in Dallas last month, include light pen control of a mosiac of choices from the computer screen, "talk along" instruction by random access audio to accompany freeze frames, fill in blanks by use of "word templates", independence from the computer keyboard, a vocabulary check with a "word bank" of a few visualized definitions, and on end user target price in the neighborhood of [redacted]

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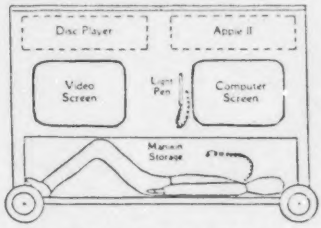
Reprinted from "Videodisc News" February 1983



Possible System Configuration

Light Pen Interact

More specifically, the light pen control on a computer monitor will totally free the student from the computer keyboard, which will in fact be hidden. All interaction will be through the computer monitor screen. A constant source of choices will be offered on a 9 point "choice menu" which the student may call up instantaneously to review (frame by frame if necessary), to challenge sections (or the whole course!), to opt for practice in the most difficult areas, to ask for immediate definitions through the vocabulary check, or to explore material which treats lesson material in reference fashion, to take a break and return (a month later if necessary) and to resume the program at the point it stopped.

Talk-Along Instruction

The 54,000 frames are less valuable if they cannot be used in sequences accompanied by sound — which may not interact with moving sequences. This is accomplished by a random access audio system whose speed of retrieval matches that of the videodisc.

Fill-In Blanks

A *word template* system will allow the recall method of evaluation to be used for key concept words. In this system, the light pen enters letters from an on screen alphabet and the computer evaluates only key combinations. For instance, for the word "pulse" to be correct, when all the blanks are filled in the computer would scan the answer to see if the letters PLS were there in that order. If they were, the answer would be correct.

In addition, a few high res graphics may be used for the student to indicate locations on the body. At this stage high res as well as extensive text may be limitatins on the 48K computer (with 100K + on floppy disk) because both of those modes require heavy memory usage. The ideal is to have the micro computer act as a "manager" of the mosaic course structure, and the 48K Apple II is quite capable in this regard, because it is more flexible in real time applications than many computers with high speed and voluminous memory.

Vocabulary Check

Approximately 200 frames are stated for the vocabulary check. Most of the definitions will be visualized and constructed in levels of complexity. The first definition will be crisp and simple, allowing the student to understand quickly and return to the program. If the student chooses, however, he may "explore" with a touch of the light pen, into more detail on most concepts. This is part of the mosaic concept of learning. Recognizing that certain objectives must be achieved, this system also tailors the course to vagaries in each student's learning method and caters to deeper interests in certain topics as they arise. Also, this method allows levels of depth in this medical program for people who want more "medical" definitions. In this way, several levels of learning can be satisfied with one nucleus program (something to think of when amortising front end expenses.)

[redacted]

The low target price is necessary to the broad outreach of CPR training which the American Heart Association would like to encourage. The figure would present few problems to institutions who would like to expand ongoing CPR programs but cannot justify the manpower or logistical resources. The system can be used for training 1 person or up to 4 people (individually evaluated) without an instructor, or as a rapid recertification tool for those who have taken a CPR course before. A conservative figure on the number of people who could be recertified in a year, if they had had a course 6 months before, is 1,700 if the machine were in use 2 hours a day.

Although there is no absolute time for completion of a mosaic course, and although the ability to take the course quickly may vary from 1 to 5 hours depending on prior medical knowledge, it is estimated that the average for 1 person taking the total course might be about 2 hours, for 4 people, about 4 hours, for a recertification after 6 months about 30 minutes, and for a recertification after 1 year, about 1 hour.

Although no marketing arrangements have been finalized, it is thought that placement of players in as large a network as would need CPR training, could well open avenues for other software (the production of which is now "hesitant" due to the lack of a large network of videodisc players.)

The system was invented and designed by David Hon, National Training Manager of the American Heart Association. He has to this point, received some technical assistance and equipment from Sony, through Don Harris and Ted Sato, and similar assistance from the Laerdal Medical Corporation, which makes the most used training manikin. Video for the system was produced by Jane Sallis and programming, mostly machine language, was done by Bob Sander Cecerlof. However, the greatest impetus he says, has come from the top volunteers of the American Heart Association whose support of this undertaking Hon calls "visionary" and "in keeping with their leading edge philosophy" in research and technology related to cardiovascular disease.

When the system has been perfected through extensive evaluations, the video disc/microcomputer combination instructing CPR from the victim's point of view, could mean on exponential outreach of CPR training and its final product, the saving of tens of thousands more lives each year. *(David Hon, American Heart Assoc., 7320 Greenville Ave., Dallas, TX 75231; 214 750 5474)*

For subscription information call 1-800-424-2723 Ext. 103 or write: P.O. Box 6302, Arlington, VA 22206

[From Videodisc News, Aug. 1981]

Disc Business

TOWARD REAL-WORLD APPLICATIONS

VI. The Chicken and Egg Marketplace

By
David Hon

Some of us remember the dilemma of the early days of broadcast television, before Uncle Milty and Playhouse 90, before Ed Morrow and You Are There. The dilemma was that although television itself was a reality — sets were for sale and some small amounts of local programming (movie serials and a few B movies) played for a few hours a day — there was really no immediate outreach of television. But we kids knew its power, first hand. We kids crowded into the dining room of a rich unpopular classmate (whom we would never have visited otherwise) just to see *anything* on television. However, network television might easily have foundered until 1960, or later, but for a combination of Flash Gordon, Madman Muntz and . . . we kids.

It was a chicken and egg situation. The manufacturers of television sets had their products ready to go, and stations had licenses and personnel to broadcast. And yet no one bought the sets. Why? Because there were very few decent programs.

And there were top flight talents ready to produce quality television programs, yet no one sponsored their efforts. Why? Because there were not enough homes with television sets to spur advertisers to pay for programming (these same advertisers who now pay $60,000 a Super Bowl minute).

What was needed was a catalytic event, one which fused the hardware and the software into one happening, which *caused* the establishment of a network of sets (or players) to allow people to see certain programs (or software).

Enter Flash Gordon and Madman Muntz.

Believe it or not, we kids gathered daily at the rich kid's house to see Flash Gordon and only Madman Muntz (who made Muntz TVs) knew that we were the catalytic event. In the fashion of the day (when kids were told by radio heroes which cereal to sneak into their mother's shopping carts), Madman Muntz set us singing. On radio commercials he had a precocious child sing "I want a television Christmas." And soon all of us who had seen Flash Gordon were singing "I want a television Christmas" all through the days of November and December, all through the living rooms and hallways and kitchens, all through the nation. And lo, enough parents broke down and bought Muntz TVs (400 to 500 thousand) that the advertisers finally broke down and funded Network TV. Which in turn prompted more people to buy television sets to see Uncle Milty and. . . you know the rest. But remember, Flash Gordon, Madman Muntz and all we kids up and down streets like Belmont North gave you the modern miracle of network TV.

The videodisc awaits a similar catalytic event — or two or three.

THE SITUATION NOW

Most of the prophets agree: when significant non-linear programming is conceived and produced, the videodisc will take off. Already MCA's "football watching" and "Kidisc" have pioneered this frontier, but those applications only point to truly productive, or truly entertaining uses of the videodisc. Meanwhile we are watching RCA and the *linear videodisc*.

The Linear Videodisc

Those who feel the greatest potential lies in optical laser random access non-linear programs are watching RCA's outreach like battered Liberals watch Ronald Reagan, shaking their heads at the amount he is accomplishing and the support he *does* have. In fact RCA is trading on some facets of the videodisc concept which will be very important in establishing a market foothold. They are showing the public that the videodisc (player and disc combo) is:

1. Easy to use;
2. Inexpensive;
3. Very high quality;
4. Very durable.

Now, if your public walks into the store inculcated with these perceptions of the videodisc on four fingers of one hand, the whole videodisc movement has gained an incredible edge on general ignorance. And if perhaps RCA has at least one other trick up its sleeve — a latent random access capability of *any* precision whatsoever, then they may indeed make their money and be a legitimate bridge to more sophisticated programming.

Whether or not that is the case, RCA has educated the public to some very basic virtues of *any* videodisc.

The Non-Linear Videodisc

How long the general public's perception of the videodisc stays on freeze frame at the linear advantages rests squarely on the shoulders of the software designers and producers. . . and on the optical laser hardware people who must begin scheming and dealing to support broader reaching software which shows the value of their marvelous hardware.

There seem to be only two steps which must occur, but they are not easy:

1. *Chart Uniqueness of Non-Linear Approaches*
   The brainstorming sessions should be running rampant, to fashion out what a random accessible videodisc can achieve which is truly unique. If the same thing can be done with videotape, with non-random access videodisc, or with computer graphics, then the non-linear videodisc has less of a case.
   We are beginning to see programs in addition to the previously mentioned MCA products which achieve this uniqueness. Many archival uses are springing up rapidly. Our program, which instantly feeds back results and coaches performance in CPR, can *only* be done with a random access videodisc and microcomputer.
2. *The Chicken and Egg Event*
   Once the uniqueness of the non-linear videodisc is well demonstrated, once that clear exclusivity (not just superiority) of videodisc for certain applications is shown, the battle is not yet won.

100

The most important step will be the nature of those few applications which will become "catalytic events".

The catalytic event will make a three way marriage. The hardware and the software together will come up against a screaming frustrating need which has never been filled and for which buyers will pay dearly to fill. Perhaps that need will be artifically stimulated, but most likely many real ones now exist, waiting.

The reason such needs and their fulfillment will be *catalytic* to the videodisc movement is that buyers will not be buying "hardware" or "software". They will be buying a combination which fills their need. (If CPR is such a catalytic event, it will in fact be because organizations are buying CPR certification on an ongoing basis.)

So disc makers must think like marketeers. *Not* "who can we get to like what we like and buy what we already have", but "who has an unfilled need?"

Flash Gordon and Madman Muntz upset households to achieve their catalytic event. The parents, driven to the wall by we singing children, were not buying hardware or software, but "peace". The purchase of a TV came to seem a small price to quiet rampaging children. The fact that the price may have been high indeed. . . is another diatribe.

In the present case of videodisc any salesperson will tell you that there is little reason for a buyer to buy hardware unless it plays software which either solves *a problem or creates an opportunity*. Surely the computer world discovered this early on. And unless we designer-producers are able to state in very clear terms how the videodisc can solve problems or create opportunities, we have on our hands a technological orphan. No bones here. We may have a Spruce Goose, admirable from so many points of view, but finally without takers.

A FEW WAYS THE RANDOM ACCESS VIDEODISC CAN SOLVE PROBLEMS AND CREATE OPPORTUNITIES

1. *Absolute Results in Training*
   With the microcomputer, it is possible for the videodisc, well designed, to achieve absolute results in training, in a manner which is extremely people-oriented.
   If that can create million dollar opportunities (such as cross-training and synergy and interfaces intervally) and solve million dollar problems (such as turnover, transfers, customer training, etc.), for sure, demonstrably, then CEO's usually have no problem signing checks. This much money for these far greater results.

   The only catch to this is.
   No Maybe's. Every new pilot must be able to fly a 747 from here to there or not pass the training in the first place. That's where needs assessment and instructional design and evaluation becom e paramount, perhaps more important than quality production.
2. *Easily Accessible Graphic Motion Archives*
   The microfiche probably allows less expensive rapid access graphics archives than the videodisc, or at least provides good competition.
   It is the area of mixing a few seconds of *crucial motion* with still frame graphics that the archival case will really be made. Otherwise microfiche are more updatable.
   So a videodisc maintenance manual can actually show the screw being turned for a few seconds. And that even more than capacity and rapid access, should be the final determiner.
3. *Pre-Experiencing*
   This may become a new branch of training, which puts already good practitioners into new situations and lets them pre-experience what they would do and see the results. Now this is different from the "absolute results training" above. It will be used to *sharply hone* both individuals and teams (such as an operating room staff) so that many situations they might encounter have been "pre-experienced". This will make quickly studying alternatives an will make quickly studying alternatives and decision making much simpler in the real situation. And when the real situation is not *quite* like the "pre-experienced" the individual or team will still have fewer variables to adjust to. The combination of realism and random access will make "pre experiencing" possible in the near future.

Those are three ways the videodisc can prove itself, for sure. There should be numerous others, especially in combination with timesharing and other computer methods already intact.

But those of us who were with Flash Gordon, Madman Muntz and the 1949 children's crusade which transformed American evenings, know that the chicken and egg must have that final fiendish twist. If we find it, the non-linear television experience may exceed the outreach of all network, cable and satellite TV we can imagine. Standby.

The fiendish twist that is necessary *might* come from one of these sources:

1. *Key generic training* in various industries. Our CPR program may be of this sort. (In a bank vault, I have six other non-medical ones.)
2. *Solution of one major problem* which *dwarfs* cost of hardware network *and* software creation.
3. *Hardware offered at cost* by a large software producer, publisher, or film company.
4. *Imaginative leasing* or *rental* arrangements. Somewhere this unsung genius of American culture will surely emerge.
5. *Hardware producers offering free or low cost* software to kick off their system sales.

Or, most probably, it will come from an unexpected side track. The disc producer's task is to find large needs and fill them. But the fiendish twists reside only in the hearts and minds of America's Madman Muntz's. That is perhaps the greatest reason for optimism. Somewhere on a commuter train at this moment, this generation's Madman Muntz is already scheming, and he'll step forward when the time is right. You know he will.

No one will call him a hero, they never do. But he'll be embarrassingly rich and we'll all be realizing our undreamed possibilities. So call it even. . .

And let's welcome the much maligned madman to the fray.

[From Video User, Sept. 1981]

interactive video

by david ross

What the Space Invaders are trying to tell us

Video is hurtling toward a change of major proportion, one which will drastically affect the lives of all video users who do not read the signs. Only a few years ago, the television screen was a place for presentations. You watched, it presented. Many of us fashioned careers around creating these screen presentations, and the measure of our competence was how attentive the viewer was to the show, how transfixed he remained by our artistry, and, occasionally, how much that viewer learned.

While we were busy living that assumption (that if our television show was good, people would watch motionless and entranced) the computer folks were making another assumption. They were busily designing useful tools for indexing and manipulating and retrieving information. Information seems to have almost endless growth in a prospering business, and computers were (and are) the M.A.S.H. units amidst the information battle. So the computer folks have worked on the assumption that the TV screen is to pass information, and not a place to put on a show.

Circle no. 168 on readers service card.

Different view of TV

But what the *Space Invaders* video game came to tell us, first of all, is that all bets are off. Bets are off for the video folks who thought a good show rivet...d the audience for 20 minutes, and bets are off for the computer folks who thought screens were for the passing of voluminous dull information.

The second thing the *Space Invaders* have come to tell us is about the nature of interactivity — this even as we try to break up existing videotapes into segments for easier linear learning. They tell us that for people to interact simply, and obtain what they wish to obtain from an information experience (reference, learning, entertainment), the designers and producers will have to deal in much more production complexity in order to make the experience seem simple.

The third thing the *Space Invaders* tell us is what they told me. When beginning an interactive video disc project, I visited electronic arcades on two successive Saturday afternoons just to see why people there parted with quarters as in Las Vegas but with no chance of those quarters returning. What indeed was happening that the media learning field could use? Well, once one strips away the stereotypes of "games" and "fun" and "entertainment," one is left with a picture of people intensely involved. They are as intensely involved as teachers might ever wish learners to be, as intensely involved as artists might ever wish their audience to be.

Video experience must be engaging

I saw that the video experience didn't have to be entertaining at all. It had to be "engaging." And when it was engaging to the participant, he willingly entered another world like Alice in Wonderland. And once there, he developed some stake in that world that kept him for many many quarters, usually. So there were three principles to be learned, worth a great deal, I think, to people considering interactive video:

1. *Engage interest* - It should give a *direct* personal response. (Not push this sequence and return, but touch this button and you shoot a martian — no ifs, ands or buts).
2. *Be relevant* - The other world has to be very quickly relevant, and not require a long, studied explanation of the situation.
3. *Offer a stake* - The person has to gain a stake in that world, skills or scores he has attained and knows he could better.

But there is a fourth thing the *Space Invaders* are trying to tell us, and I didn't realize that until I had used these three principles to make a truly interactive videodisc and hands-on learning experience out of cardiopulmonary resuscitation, and we began to be able to show (rather than just tell) what interactive video might be capable of doing. And that fourth thing may be more important than all the rest.

The *Space Invaders* are trying to tell us that interactivity, whether through a computer, through a small class discussion, or through a good interactive video program, will be taking power away from the one-way program. This is because an interactive video program gives the power back to the people who want the program. And the more interactive the program—video, live, computer—the more power the user has over what content he needs and doesn't need. Many users may never want to go back to merely watching a linear TV show—now when they can share the power.

So from a most unexpected quarter—through the television screen, the *Space Invaders* have brought power to the people... and the people seem to like it. This means, of course, that video people are going to have to learn the difference between linear and non-linear programs. (We will be able to tell those who don't know the difference because they will continue to ask "How long" - program is, rather than what it achieves). The new designs will be created, with 100 video branches shot to the user co...ution of all but the producer. The new equipment — video tape and video disc — will stress speed of access, and some of it, as equipment, such as light pens and touch screens, will make it easier for the user to interact with more complex programs.

This is what the *Space Invaders* can tell us, if we listen.

So that's the promise of interactive video. Power to the people. And that will be what underlies this column, and the many rapid changes in video we all have in store for us.

Thank you *Space Invaders*!

[From Video User, Dec. 1981]

interactive video

by David Lachenbruch

How devices restore democracy

Do you remember when people used to clap at movies and talk back to their television sets? They were making a transition then, out of the interactive mode ... sad been Democratic Many proponent since the shouting at the Roman forum. They were making the painful transition to a totalitarian state of communication, where their plight was to sit and watch, voiceless, helpless. People won't clap at movies again. But we in ... eractive video may be able to restore some democracy.

In the early days of television there was a children's show called Winky Dink, one portion of which was almost interactive. The child-viewer had been told (by mail) an adhesive transparent cellophane sheet which was laid across the TV screen. Illustrations were broadcast and the viewers were asked to trace basic lines. An arrow would point to the lower right corner and the narrator would say, "Draw a tree here." Then the broadcast picture would have a little bear sniffing around the viewer's tree, and so forth. Pretty interactive, really, for those days.

At that time this was seen as just one more clever idea in the kaleidoscope of possibilities for the young medium. Probably it was discontinued because angry parents (who hadn't purchased the transparent shields) were tired of scrubbing crayon off the TV screen.

The range of devices, and your selection therefrom will strongly influence the limitations to interactivity...

If we intend to have truly interactive video, we must do some very hard thinking not only about the way in which the viewer will approach the program, but the extent to which the viewer's own message will truly affect the media program. The range of devices then, and your selection therefrom, will strongly influence the limitations to interactivity and the potential of a viewer to operate as an individual in relation to the program he or she is supposedly participating in. So let's make an abbreviated list of types of interactivity going from "stop-start," to some forms which—with the help of a computer—can allow true performance and extensive thought to be communicated by the viewer back through the tube.

Stop-Start

The simplest form is "stop-start" which funnies (film) became possible with reel-to-reel video tape, more possible with cassettes, and still more possible with the video tape pause feature. These seemingly small advances allow viewers to stop, go to other material, have discussion with classmates or instructor, and then continue from the point they stopped. But such interactivity depends on your having something else to go to.

Programmed operation on media

Only very recently, actually, has it become possible to program sections of the presentation so that the viewer can hit prescribed keys on a control and arrive at specific segments of interest. Both video tape and many optical laser video discs have this capability of imprinting programmed stops on the medium itself. This may be especially effective for point-of-purchase displays in stores, or in libraries or personnes offices which may use such means to explain any of a smorgasboard of services.

Programmed operation off media

Once again, several models of tape and video disc offer a programmable control, which you can use to sequence material, to keep that sequence in memory, and (with video disc) to program freeze-frames, slow motion or other effects.

Adding a microcomputer

The methods mentioned so far have an increasing level of desirability accompanied by increasing costs. However, the addition of a microcomputer puts such a new dimension of cost, capability, and possibility into the picture that the following methods should be considered: (1) all of a much higher order of magnitude in design potential and (2) not necessarily more or less desirable in the order mentioned.

Keyboard control

The microcomputer keyboard as an interactive device for both the computer terminal and the video screen is extremely flexible because so many of its functions can be used for the viewer interaction. For instance, the screen might ask "How many people are needed for a bridge game?" The viewer can answer "4" from the keyboard, and many philosophers would say there is no better or more complete way that questions could be answered with any device. So the other alternatives need to be evaluated on just what they do better than the microcomputer keyboard could. The keyboard of TRS-80, or Apple II or IBM terminal could be an excellent device for receiving very complex inputs, the evaluation of which by the computer will cause the computer to select one of many branches from the video (tape or disc) segments. There are also reasons to use other devices.

Voice activation

Although this technology is now only

embryonic, it will get better. But I think we need to ask right now if even an ideal voice detector would always be the ideal method of interaction for the user. We know people who express themselves best on the piano, with a sketch pencil, or in writing. All of these means communicate thought, and there seems no reason voice should be the epitome of inputs to the interactive program. It is simply a communication tool unique to man, but also developed from his limitations. Sacrilegious though this may seem, there should be nothing holy about speech as a means of communication. It's the thought that counts.

Light pen and touch screen

These methods, used with ingenuity as the large PLATO computer system does, can actually allow more possibilities for a program to receive human intelligence

than most other means, certainly more than voice activation. With light pens and touch screens one can select from menus or choices, and actually draw an answer on the screen. (Move your finger

Continued on page 23

Interactive devices....

Continued from page 21

on the screen graphic across the area where you would make an incision.)

Other peripherals

As in our CPR program (at the American Heart Association), it seems that other peripherals could be developed for input, just as computer games now have joysticks to fly airplanes. Ours uses sensors on a manikin to analyze hands-on CPR performance from the victim's point of view. Certainly that is only one of many devices that could be used in specific cases.

Talking transparency

The closing word on devices must be "transparency," the computerist' term for "ease of use" and "direct relationship of the viewer with the program." In talking transparency in interactive video one might observe that if the viewer must "press the appropriate key to answer A, B, C or D and then press return" on the keyboard, we have two obstacles to transparency:

(1) The key symbolizes the answers. In touch screen you can touch the answer itself.

(2) The two-step procedure (press the key and then press "return") means a delayed response. The subliminal effect is that you are working for the system instead of the system working for you.

This has been a long column. But it is absolutely necessary for the potential maker of interactive video to consider the user's end of the interaction. This is very important to design and implementation. And if you want to see transparency done well, once again visit the arcades and see the Space Invaders. Rather than wanting to see our leaders, in interactive programming, they are leaders.

[From Time, July 26, 1982]

Video

And Now, Dynamic Discs

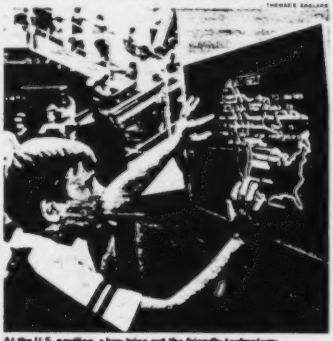
New TV technology opens a world in which touching is believing

The child's hand reaches out tentatively. Years of harangues ("Keep your greasy fingers off the TV!") have made the screen taboo. But when the child sees that his finger causes the image to change, learns that his touch magically provokes new pictures, sequences, words and diagrams, his hand begins to jab, rub and slap the screen. Curiosity, once aroused, is satisfied by simply touching a picture of what one wants to understand. This process is re-enacted thousands of times every day at the U.S. Pavilion at Energy Expo '82 (a.k.a. the Knoxville, Tenn., World's Fair) as exuberant children and their more inhibited parents discover that TV viewing is passive no longer. The technology is called the interactive videodisc: the symbiosis of the computer and the laser-vision disc.

Clustered inside the wedge-shaped steel-and-glass pavilion are 42 TV screens connected to 42 Sony videodisc machines, which are hooked up to 23 Apple II computers. Nine video stations on the ground floor explain the meaning of 480 energy-related terms. Don't know what a Pelton wheel is? Press the word on the screen, and presto!, a swirling water turbine appears. A different set of screens shows a colorful cutaway drawing of a house. Wondering how to make your home energy-efficient? Just touch the attic, for example, and watch a demonstration of how to insulate it. According to Emmett Cunningham of the U.S. Department of Commerce, the genial director of the exhibit, "It's the best and most durable public information system I've seen in 25 years in the exposition business."

The system, says its unflappable designer, Tom Nicholson of the New York City exhibition firm of Ramirez and Woods, "personalizes" information. Determined to avoid an intimidating computer keyboard, he employed a "user-friendly," touch-sensitive screen. Pressure on the screen tells the computer to retrieve the information stored on the videodisc corresponding to the word or symbol touched. Although the computer makes the system truly responsive, what makes its applications so exciting is the versatility of the videodisc. And you thought the disc was the ideal of video technology.

Alas, the poor videodisc, so misunderstood, so maligned. Most people think it a single-purpose instrument, a movie machine. The misconception was fostered by the much ballyhooed introduction in 1981 of RCA's SelectaVision, 15 years and $200 million in the making. Not a truly innovative technology, SelectaVision is essentially a phonograph that uses a mechanical stylus to play prerecorded movies. Its costly debut obscured the second type of videodisc, the infinitely more versatile laser-vision disc, designed for the videodisc player introduced by Magnavox in 1978. Manufactured by Pioneer, Sony and the 3M Co., the laser-vision disc makes flexible interaction possible.



THOMAS E. FRANKLIN

At the U.S. pavilion, a boy tries out the friendly technology

Don't know what a Pelton wheel is? Press the word, and presto!

More sophisticated and more expensive than the stylus disc, the laser-vision disc not only offers enormous storage capacity but provides random access and perpetual durability. A low-powered laser beam "reads" billions of microscopic pits of information imprinted on the smooth, shimmering disc. On each side are stored 54,000 images, any one of which can be called up instantly on command. The stylus and laser systems are incompatible, which leads to a great deal of consumer confusion. Moreover, unlike the video cassette recorder, the systems cannot record from television. Currently there are three videodisc machines on the market using laser vision and ten using a stylus. Despite exaggerated reports of the disc's demise, both the stylus and laser players are selling better than color television did when it first appeared 18 years ago.

The applications of the laser-type videodisc are limited only by the imagination, and applications even more innovative than the one in Knoxville have been developed. Examples:

▸ The "movie map," created by the Architecture Machine Group at M.I.T., is a visual record of every road, building and tree in Aspen, Colo. It enables the viewer, or "driver," to find his way from street to street by touching the left, right or center of the screen. If he wants a tour of city hall, he merely presses the image of the building as he drives by and is suddenly inside, listening to a curator talk about its history. Perceiving the potential of this kind of system, the U.S. Navy has commissioned the same designer to create a "visual toolbox" to track the operation and repair of some of the Navy's more complex hardware.

▸ The cardiopulmonary resuscitation disc, developed by the American Heart Association to instruct trainees in saving cardiac arrest victims, is so interactive that it practically cries "Ouch!" The disc is linked to a mannequin equipped with 14 sensors, and it tells the trainee exactly where to push, pound, punch or pummel. Instructing the trainee how to compress the victim's chest, the videodisc might say, "Find the notch on the sternum," or perhaps, "A little more gently this time." At the course's conclusion, the system gives a complete exam, grades it, and can certify the student in cardiopulmonary resuscitation.

At the moment, interactive programs are being used or developed at Atari (the disc acts as an indefatigable salesman in the showroom); IBM, Sears, Roebuck (Looking for a gingham dress? You can find it on their videodisc catalogue); General Motors; the Smithsonian Institution, Walt Disney Productions, Xerox, and the National Gallery of Art (recording 16,000 works of art for scholarly delectation). As a teaching tool for schools, industry and museums, the interactive videodisc has an assured place. But just as the use of the home computer depended on the marketing of interesting software, the videodisc player's consumer popularity awaits the creation of enticing disc software and increased awareness of the computer in the home. It should be understood, says M.I.T.'s video wizard Andrew Lippman, that "the videodisc is peripheral to your personal computer, *not* the television set." And that the admonition "Look but don't touch" applies to oil paintings, not TV screens. —*By Richard Stengel. Reported by Peter Almelo/Knoxville and Lisa Towle/Boston*

PREPARED STATEMENT OF DENIS EICHHORN, REGIONAL MANAGER FOR EDUCATIONAL SERVICES, CONTROL DATA CORP., WASHINGTON, D.C.

Mr. Chairman and members of the Committee, my name is Denis Eichhorn, Regional Manager for Educational Services for Control Data Corporation. I'm here to give you a brief overview of Control Data's activities in applying computer technology to education and training problems.

Control Data Corporation is a worldwide computer and financial services company based in Minneapolis. It employs some 60,000 people and sells products and services in almost 50 countries. Its combined total revenues last year were more than $4.1 billion.

Control Data's long-term business strategy is based on the belief that society's major unmet needs can be addressed as profitable business opportunities. As William C. Norris, Control Data's Chairman and Chief Executive Officer, told the Senate Subcommittee on Intergovernmental Relations last year, these business opportunities exist because reliance on public programs has failed to end the decay of our inner-cities, the poverty of our stricken rural areas, the unemployment of disadvantaged youths, the overcrowing of prisons, and the problems of inadequate education and training. "We need fundamental change where business takes the initiative in partnership with government and other sectors to address societal needs as profitable business opportunities," he said.

A major aspect of this strategy has been the development and implementation of education technology, with a primary focus on the unique needs of people seeking employment and of training people for particular job skills. One of the results of Control Data's commitment to education and training is the computer-based system called PLATO. The PLATO system is specifically designed, to deliver computer-aided instruction and computer-managed instruction in an effective and efficient way. I stress the word current because the PLATO system by its very nature is constantly evolving and changing. Today it includes delivery of both large, centrally-based computer systems and communication networks, as well as the small stand-alone microcomputer which some of you probably have in your homes today.

Most of us, in thinking about computer companies such as Control Data, think in terms of hardware and high technology, but let us face it—Control Data does not have a monopoly on computer technology. You can look around the room this morning and see a number of examples of computer technology developed by various manufacturers. The real issue then is the training that the technology delivers. It is in this area that Control Data is focusing its primary develpment efforts, making it the country's leading electronic publisher. Effective courseware must be understandable by the student, and must hold the interest of the student. Authoring of course material must be easy for the non-computer professional and must also be economical to use. We want to be able able to capture the thoughts and techniques of today's effective teacher.

Control Data is investing considerable effort in the development of an authoring system which is both easy to use and facilitates courseware development for not only Control Data's PLATO terminals but those of other manufacturers as well. Courseware has been developed by Control Data for the elementary level student. The Basic Skills Curriculum is a remedial program developed for youth. It has been used effectively in both government agencies and public school systems. The Basic Skills Curriculum covers the competencies of mathematics, reading, and language from grades three to eight. A significant portion of its value to educators lies in the placement test which establishes which skills are in need of remediation and provides a program of study for the individual student. Tutorials delivered through the terminal teach to the demostrated need, and the student is tested for mastery. In this way, each student maximizes available learning time. Under development is courseware in mathematics, English, and science, which will carry the student from the eighth grade level through the twelfth grade.

In higher education we are working with a consortium of five major universities across the country to develop a curriculum which fulfills requirements for the first two years of an engineering education at most colleges and universities. This curriculum by itself would be very applicable to community colleges and vocational schools where students need grounding in basic science and engineering fundamentals. It will also provide a gifted student curriculum for the secondary school system.

The Control Data computer literacy curriculum which is under development will provide a comprehensive series of lessons in this subject. This material will permit tailoring to address the needs of teachers and students from grades eight through

12, the computer science major in college, as well as the vocational trainee whose interest is in technician level instruction.

During the 20-year development period, Control Data has achieved a number of notable results, all of which verify the effectiveness and parcticality of utilizing computer technology to enhance and improve the education and training process. For example, in 12 secondary schools in the State of Florida, it was found that math instruction delivered by PLATO terminals could impart at least ones grade level of improvement with every 20 hours of terminal contact by the student. Other school systems have reported similar results. Control Data is sponsoring a joint venture in the D.C. School System. Eight terminals will be utilized to deliver instruction to 400 students at the Spingarn High School in northeast Washington. There is more statistical support validating its effectiveness.

Through a program called Fair Break, Control Data is delivering remedial and work readiness training to disadvantaged, unemployed youths in over 50 locations throughout the country, using computer-based education as a primary medium of delivery. Fair Break survey results show: 90 percent of program completers pass their GED exam; 83 percent of completers are placed in jobs for further vocational training; and 73 percent of those placed in jobs are still employed six months later.

At the Department of Army, PLATO is being used to train recruits who do not have desired levels of competency of reading, math, or English. Utilization of PLATO-delivered training has shortened time required to achieve necessary levels of competency by 20 percent, thus helping both the Army and the recruits.

There are many statistics supporting the improved speed with which the student can learn, compared with traditional methods. It is more difficult to capture statistics for the improvements in attitude and motivation on the part of the students. For example, Dr. Anne Emery, Assistant Superintendent, Office of Public Information and Communication, Baltimore City Public Schools, has said, "I have seen PLATO excite students and make them want to learn. I have seen the improvement in attitude and grades. It will be to their everlasting shame if educators do not get involved with, support, and use the system."

Another aspect of computer-delivered instruction is the increased mobility which it offers and the linkages which can be made much more easily between our public institutions. One local example of this is a program which was jointly entered into by the University of Maryland and Control Data to deliver PLATO services to the Baltimore School System and the Baltimore CETA prime sponsor. Control Data turned over to the University of Maryland its PLATO client base in the City of Baltimore. The University of Maryland has acquired their own central PLATO delivery service and is now in the early startup stages of delivering PLATO services to the greater Baltimore communities. This has resulted in linkages between the university of Maryland and the Baltimore School System. Both the University and the School System in Baltimore will be the benefactors, and the education of the public school student in Baltimore will be the primary benefactor. The concepts such as the wall-less classroom can easily be implemented with this type of technology.

A number of major corporations are using training delivered by Control Data, such as General Motors, Dupont, United Airlines, Shell, and Federal Express. All of these companies are looking at the issue of improved productivity, and they are achieving that improved productivity through training. To effectively deliver that training, computer technology is the only practical way to go today. Labor and travel costs are just too high. Furthermore, because of the nature of the training which must be delivered, one must insure that it is delivered accurately and effectively and that the individual understands the material thoroughly.

It has been said that, if productivity is America's problem, the solution is education. Computer-based education is the means of delivering education efficiently and quickly.

Application Report

CONTROL DATA

How the computer systems and services of Control Data Corporation are used in education

PLATO System Spurs Baltimore Students to New Achievements

by Anne O. Emery, Ph.D.
Principal, Walbrook High School
Baltimore, Maryland

Last June (1979), 200 of the 538 Walbrook High School seniors failed City of Baltimore mathematics and/or reading proficiency tests mandatory for the first time for graduation. Needing a quick, effective solution, we decided to reeducate the students with a concentrated, computer-based basic skills learning program.

After 60 days of using the Control Data PLATO system for basic skills instruction, all but nine seniors passed the mandatory tests.

Although we have used the PLATO system at Walbrook for more than five years, including a small pilot operation, we have only 12 terminals. Many of the seniors who failed the tests last June hadn't had access to the computer-based education system. If we had our "druthers," we would have 100 terminals because a large number of students enter Walbrook High, an inner-city school, with reading and math skills below the sixth-grade level. The staff of just 110 teachers has only three years to work with 2,500 pupils.

Fortunately, though, 90 percent of the students chosen for the PLATO program increase their achievement levels. Youngsters at both ends of the learning spectrum have advanced as many as three grades within a single school year. Because of those results, we apply the PLATO system as much as possible.

More than 200 students currently are taking basic skills, about half of them in mathematics and half in reading. Another 60 are in foreign language classes, and we have a smattering of gifted youngsters taking subjects not usually taught at Walbrook.

Altogether, about 125 children receive PLATO instruction daily, usually spending half of a 50-minute period at a terminal, learning a skill, and the other 25 minutes in a more conventional teacher-classroom session, learning how to apply the skills.

Our staff recommends students for the PLATO program; department heads give approval. Seniors needing remediation have priority. Based on information from a pretest taken by a child at a terminal, the PLATO system then suggests where the student should be placed in the curriculum and which instructional material should be utilized. A youngster usually spends one semester on the system.

Getting students to use the terminals is no problem. They are clamoring for them at the beginning of the day; we have to chase them away in the afternoon, and they would come in on Saturdays if the school were open.

Moreover, some parents have moved into the Walbrook district so their children, both gifted and those needing remediation, could take advantage of the PLATO system.

Computer-based education is just one of several approaches we use to motivate our children. But it is one of the most effective because the PLATO terminals provide an individualized, self-paced training environment in which the student competes only against himself or herself, eliminating unnecessary peer pressure and embarrassment. This defuses the hostility found in a child who has experienced a lack of success in the past and anticipates a lack of it in the future.

Each unit within the PLATO Basic Skills curriculum has one or more objectives which the student must master before he or she can move on to another unit. The beginning units have several simple objectives; as the student progresses, the objectives become more complex. However, the student may repeat all activities in a unit as many times as necessary to master a given objective. And no one, not even other students working at terminals alongside, is aware of how long it takes.

Ninety percent of the Walbrook students who used the PLATO system in a remedial program advanced three grades in one year.

By presenting material in small increments, the PLATO method enables the student to build a history of successes. It encourages him with immediate feedback, impossible in a conventional classroom system. This reinforces and supports the successes and motivates the student to work harder because he sees that he can learn. By contrast, the conventional learning approach may take so long that the child is turned off and quits trying.

continued ▶

PLATO is considered an aid to teachers as well as students. Teachers receive precise performance measurements that indicate if a student needs personal help.

Teachers Learn Immediately When Student Needs Special Help

Student interest remains high while the child receives PLATO instruction thanks, in part, to course content, to dynamic, animated cartoon displays and to the interactive nature of the presentation. The students respond by simply touching the terminal's screen or keying-in data. They can even choose paths of instruction, thereby gaining greater control of their own learning environments.

The Basic Mathematics Skills course includes number concepts, arithmetic operations involving numbers, fractions and decimals, and special applications topics involving ratio, proportion, percent, geometry and measurement. The Basic Reading Skills course includes fundamentals of word structure, fundamental vocabulary development and basic comprehensive skills. Also available, but not currently used at Walbrook, is a Basic Language Skills course which includes language structure and word usage, sentence and paragraph structure, and mechanics and conventions in writing.

The PLATO system provides the type of individual remediation that most teachers in typical classroom situations simply cannot give. It stores data on each student's progress, which allows the teacher to evaluate the child's efforts.

For example, if a youngster is spending too much time on the tutorial aspects, the teacher can surmise that he or she is having a problem determining the task or interpreting the reading matter, which requires only a third-grade reading level.

At that point, the teacher will spend more time with the student. With half of the average basic skills class on the terminals at any one time, the teacher has more time to work with students.

The purpose of PLATO is to assist our staff, not replace it. In fact, without PLATO computer-based education, we'd have lost our entire Latin program due to budget cuts.

The PLATO system has benefited honors students, who can use the terminals unsupervised to expand their opportunities in higher mathemat-

Emery

ics, science and foreign languages. For instance, one gifted student studies trigonometry, not usually offered at Walbrook, via the terminals. He is now doing mathematics at the college level and has been accepted at the Massachusetts Institute of Technology.

Good academic standing is required to participate in athletics, of course. And, if a student is on probation, he can't use PLATO. This is a real motivator, because the youngsters will sacrifice much to keep that privilege.

Significantly, the PLATO experience has shown that the dichotomy is not always that great between youths needing remediation and the gifted. As an example, a senior student was referred to the PLATO system as a failing student a couple of years ago. He is now an outstanding scholar, studying computer programming, helping develop programs and assisting Control Data representatives in demonstrating the Basic Skills programs to educators in other cities.

In summary, at Walbrook High School we use many means to challenge students and motivate them to achieve here so they can meet the challenges of college and/or the world of work.

The PLATO system is just one of those means, and it has been uniquely successful in helping students make quantum strides in basic mathematics and reading. Mastering those vital areas is essential if our young people are going to succeed in life, no matter what yardstick we use for success.

The only shortcoming we currently find with the system is our one dozen terminals. As I indicated earlier, we wish we had 100.

This report is published by the Public Relations Department of Control Data Corporation with the approval of Walbrook High School. © June, 1980. Additional copies of this report and information on the application are available by writing to: Control Data Corporation, Education Industry Marketing, HQA02P, P. O. Box 0, Minneapolis, Minn. 55440

Litho 202 389

BYTE
the small systems journal
- REPRINT -
"Interactive Training in Cardiopulmonary Resuscitation"
by David Hon
Interactive Videodiscs

- INTERACT -

InterAct, a subsidiary of Actronics, Incorporated, was formed to produce and market interactive videodisc educational systems with a primary emphasis in medical education and training. InterAct is now marketing a self-contained Cardiopulmonary Resuscitation (CPR) Training System, originally developed by the American Heart Association (AHA). InterAct purchased the exclusive rights from the AHA to market the CPR system worldwide.

InterAct's system utilizes a microcomputer to exploit the random access capabilities of the laser videodisc for efficiently storing and rapidly retrieving audio and video information. The resultant system enables a highly interactive learning experience to occur. Sophisticated computer software is used to quickly select the appropriate response from the Videodisc in order to dynamically tailor the instruction to the individual student's requirements and actions. This stand alone system brings together a learning theory based on performance, immediate response and feedback which enables the CPR student to learn from the "victim" rather than an instructor.

In addition to receiving the exclusive rights to market the CPR system from the American Heart Association, InterAct has also obtained the exclusive license to the Advanced Cardiac Life Support (ACLS) system presently under development by the AHA. The interactive ACLS system will utilize all of the same equipment as the CPR system.

Utilizing the interactive capabilities of the videodisc, InterAct will also be developing multiple product lines directed at providing education and/or refresher training for medical personnel.

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Interactive Training in Cardiopulmonary Resuscitation

Computer and videodisc technologies combine to provide instruction in lifesaving techniques.

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Cardiopulmonary resuscitation (CPR), when properly performed, is a technique that can save thousands of lives. Existing programs have successfully trained many individuals in the practice, but such programs have been limited by the number of qualified instructors available. If an effective, low-cost alternative to live instruction could be found to expand the programs, many more lives could be saved. The advanced state of videodisc technology suggested that a training system might be developed by interfacing a videodisc machine with a personal computer.

Despite recent progress in making computer systems and software easier to use, many people remain computer-shy. Any computer that is less than "ultrafriendly"—totally accommodating and transparent (in the sense of allowing someone to benefit from the system without having to learn how to operate it)—will frighten such people away. A systems designer can't expect them to voluntarily approach a computer's keyboard to find out how easy the computer is to use. Even an occasional pressing of the Return key is too much to ask.

The design of a transparent computer system is difficult, however, and the more complex the functions that the system must perform, the harder it is to keep the interface with the user simple and accommodating. Before attempting to create an ultrafriendly system it is wise to ask whether the project is really important enough to merit the effort involved.

In the case of the American Heart Association's program to teach CPR techniques, many thousands of lives are at stake. Some 500,000 victims each year die before emergency care arrives: children jolted nearly to death by contact with high-voltage wires, businessmen collapsed on the street, football players whose hearts have stopped after vicious tackles, fathers stricken while shoveling snow, and many other ordinary people felled in ordinary surroundings.

The mechanism of death from a heart attack is well known. Heart failure cuts off the flow of oxygenated blood to the brain. Brain cells begin to die from lack of oxygen. The medical world agrees that a high proportion of heart-attack victims might be saved if life could somehow be sustained for even a few minutes until emergency care arrives.

A Plateau in Lifesaving

But it seemed as if we had reached a plateau in the number of people to whom we could teach the lifesaving techniques of CPR. It seemed as if the number of instructors at any one time remained almost constant. Each year the number of newly trained instructors would continually be offset by the number of previous instructors who let their skills slip away. The plateau was at the level of about 12 million trained rescuers. That made the odds facing a stricken American about 18 to 1 *against* having a competent CPR rescuer present to sustain life during those grim minutes before the arrival of emergency care. Improving the survival odds even one or two percentage points could save tens of thousands of lives.

Human and organizational limits established the plateau in the number of trained rescuers. Expanding the training program through volunteers or paid instructors would always multiply logistics and personnel problems, strain finances, and increase the difficulty of standardizing live instruction.

On the other hand, conventional training media had failed to do much more than present information.

AMERICAN HEART ASSOCIATION
CARDIOPULMONARY RESUSCITATION AND EMERGENCY CARDIAC CARE
PERFORMANCE TEST FOR ONE AND TWO RESCUER CPR

NAME: _____ DATE: _____

ELAPSED TIME (seconds) Min.	Max.	ACTIVITY AND TIME (seconds)	CRITICAL PERFORMANCE	PASS	FAIL
4	10	Establish unresponsiveness and call out for help. Allow 4-10 sec. if face down and turning is required.	Tap, gently shake shoulder and shout—"Are you OK?" Call out "Help!" Turn if necessary.		
			Adequate time.		
7	15	Open Airway. Establish breathlessness. (Look, Listen, and Feel) (3-5 sec.)	Kneels properly. 'Head tilt with one hand on forehead , 'd neck lift or chin lift with other hand.		
			Ear over mouth, observe chest.		
10	20	Four ventilations. (3-5 sec.)	Ventilate properly 4 times and observe chest rise.		
15	30	Establish pulselessness and simulate activation of the EMS System. (5-10 seconds)	Fingers palpate for carotid pulse on near side (other hand on forehead maintains head tilt) Know local EMS number.		
			Adequate time.		
69	96	Four cycles of 15 compressions and 2 ventilations (54-66 sec.)	Proper body position.		
			Landmark check each time.		
			Position of hands.		
			Vertical compression /no bouncing.		
			Says mnemonic.		
			Proper rate and ratio.		
			Ventilates properly.		
72	101	Check for return of pulse and spontaneous breathing (3-5 sec.)	Check pulse and breathing.		

Figure 1: *A reproduction of part of the American Heart Association's performance test for cardiopulmonary resuscitation by a single rescuer. The CPR training system had to meet the performance standards shown.*

When the subject being taught is a hands-on skill requiring the exercise of judgment, merely presenting information isn't good enough. As a result, slides, tapes, films, and printed matter could do no more than assist a live instructor.

Finding a Technological Solution

Could a computer-based, instructorless system succeed where human teachers and conventional aids had failed? The human instructor begins by giving basic instructions to the student, who then experiments with a training manikin. The process is one-on-one coaching through repeated drills. The live instructor gives the student constant attention, commentary, and evaluation as the student works on the manikin. Often the student needs to receive instructions while keeping his or her eyes fixed on the manikin.

To replace the human instructor, then, a computer-based system had to meet a long list of general requirements. First, it should provide total, stand-alone interactivity with students. It should train people to meet the certification standards in the American Heart Association's Cardiopulmonary Resuscitation and Emergency Cardiac Care Performance Test (see figure 1). It must meet or exceed the results of live instruction at every comparison and should provide high standardization and limited need for personnel and logistics. The system should teach basic concepts as well as hands-on skills and be able to instruct the student at times without requiring the student to take his or her eyes off the manikin (in other words, coach the student aloud). The entire setup should cost the agencies that would be the end users something under $15,000. And finally, it should be accommodating, responsive, and as easy for the average person to operate as an arcade game.

These last two requirements were essential to achieving the kind of broad outreach in CPR training that the American Heart Association wanted to encourage. The rough figure of under $15,000 as the retail price of all hardware and software would make the system affordable for those institutions that wanted to expand CPR programs but could not

Photo 1: *The complete CPR training system. The Sony LDP-1000 videodisc, normally out of sight, appears in the foreground. Author David Hon is trying to revive the electronic manikin. The video screen at left shows the doctor, who is coaching Hon from the videodisc. The computer video screen at right, which the doctor refers to as 'Compy,' is showing a graphic analysis of chest compressions as Hon performs them. The Apple II computer, which manages the system, is concealed behind the drapes below the video screen at right. (Photo by Jim Sheldon.)*

justify the personnel or logistical costs of hiring more instructors.

We felt that the requirements of transparency and simplicity were as important as any of the others. We didn't believe that an instructional system that required students to develop skill in using a computer could succeed. We had learned something from games like Space Invaders: if you design a computer-based system in such a way that people know the difference between winning and losing, virtually anyone will jump in and try to win. Saving a life is a big victory and a big incentive. We were sure that if we could build a system that was easy to use and engaging, trainees would use it and learn from it willingly.

We also knew that the project wouldn't be easy. But the prospect of training thousands of people and saving thousands of lives justified the effort required. In that context, we didn't have the luxury of that technical snobbery that says, 'There's no sense wasting time on people who can't learn to use our computers.'

In short, we needed a combination of hardware, software, and online data that would answer questions on request, instantaneously gather information about each student's hands-on performance, respond to each action with appropriate spoken instructions or video demonstrations, gather data on the student's next attempt, respond with appropriate instructions or demonstrations, and so on, until the student performed up to standards—without needing to know anything about how to use a computer. We needed a more-than-friendly 'total coaching loop' for under $15,000.

We seem to have achieved our goals. Photo 1 shows the finished system in use. But there's much more to the story than any photograph can show. I hope that the following description of the development of the CPR training system will encourage others to undertake similar projects with videodisc technology.

Working Toward a Design

Reflection on our general requirements soon led us to a list of more specific requirements with clear implications for hardware and software design.

Meeting the performance standards for certification of millions of ordinary people who learn in different ways would take a large, comprehensive set of visual segments, both still and moving. We rejected the use of video tape because of its slow response time and its lack of first-rate freeze-frame capabilities. Videodisc technology seemed the only possibility for storage and rapid retrieval of the number of segments required.

We had to be able to retrieve instantly from storage the *right* video segments for each action of each student during training. This required, besides storage on videodisc, evaluation and management by computer. The computer would have to assess students' efforts, draw appropriate coaching from storage, reassess efforts and supply appropriate coaching again and again, and provide a final evaluation of each student's performance. To achieve the necessary speed, we would have to do extensive machine-language programming.

We also had to face the fact that making software for a video display automatically makes you a television producer, with all the associated privileges and responsibilities. As a former television script writer, I saw that one of the greatest challenges of this project was creating a script that embodied a system design and had a format that three unrelated groups could work with: medical experts, video producers, and computer programmers. (I'll say more on this later.)

We also needed a large set of audio segments. Some of these would talk along with videodisc freeze frames, explaining the material shown in the still illustrations. Consequently, the speed of audio access had to match the speed of retrieval from the videodisc. The videodisc can record sound and play it back, but you can only get voice off the disc when the disc is running (i. e., not during a still frame). Therefore, whenever the voice accompanies a still picture (appearing unchanged in successive video frames), you are wasting frames. You waste about 400 video frames for every 15 seconds of still picture.

Since we didn't want the user or anyone else to have to change videodiscs, we had to squeeze a great deal onto a single disc. Rather than waste videodisc space on sound to accompany freeze frames, we decided to use another audio device of some kind for that purpose. Investigation of voice synthesizers showed that they would prove too expensive for the end user and too artificial in tone to achieve the kind of friendliness that we wanted. The remaining choice was an audio recorder. But ordinary sequential-access audio recorders were out of the question. We needed a random-access audio recorder to match the speed of the random-access videodisc. Unfortunately, there was no such thing as a random-access audio recorder. We would have to create one.

To measure students performance in the hands-on skills of CPR, we would have to install a number of different sensors in the training manikin. The sensors would be peripheral input devices to the microcomputer. The manikin would "feel" certain combinations of actions and feed resultant data into the microcomputer for instant evaluation, and the microcomputer would then call up one of the hundreds of branches available to coach the learner. Because no sensory peripherals existed that were appropriate for measuring student actions and sending data to the computer, the hardware would have to be designed in parallel with and after the software. Since the peripherals were yet to be designed, we needed a computer that permitted the flexibility of adding cards later to interface with the peripherals. We chose the Apple II because of its open structure.

The data supplied by the sensors would enable the system to talk along while the student was working on the manikin. With chest compression, for example, the system would say things like, "Find the notch on the sternum," or, "Do one compression. . . . I'll give a low tone when you're close and a high tone for exactly right." To coach the student to apply the right pressure, the on-screen instructor would say "a little more gently this time," or "too deep," or "keep trying till you get a high tone."

As for transparency and simplicity, although we didn't want trainees to see the computer or its keyboard, we felt that interaction with a video screen would be all right. The television has become such a fixture of contemporary life that the screen seems anything but menacing to most people. People are accustomed to having control over television, and as the name "boob tube" makes plain, the television seldom displays anything resembling enough intelligence to pose a threat.

We decided to let trainees interact with the computer by using a light pen on the computer video screen. The light pen alone would enable trainees to learn the basic vocabulary and concepts of CPR. We would have to provide a way for the video screen to perform some of the functions normally handled by a keyboard.

The Prototype

Now all we had to do was find the right videodisc, produce thousands of video images, develop a random-access audio recorder, record numerous audio segments, write software to permit hundreds of different instructional branches of both sound and images in such a way as to reflect medical expertise in each simple response to every move by the student, and then arrange for the microcomputer to read the sensors in the manikin and the light pen on the video screen, control the audio recorder and the videodisc player, and integrate all this in a single high-speed system. As we sat down to design the prototype, we knew that it wouldn't be easy.

To make the building of the initial prototype more manageable, we decided to limit its instructional range to a single hands-on skill. CPR involves opening the victim's airway, ventilating the victim (giving mouth-to-mouth resuscitation), and performing external chest compression. Because the prototype had to convince people of the system's value, we wanted to teach the most difficult of these skills. This is external chest compression, which requires controlling three different parameters: placement of the hands, depth of action, and rhythm. We felt that if we could demonstrate that the system could successfully coach external chest compression, we could do everything else. We would consider the prototype a success if it coached 95 percent of its students to a high level of performance.

Rather than give separate and sometimes overlapping accounts of the development of the prototype and the later development of a full, multifunctional system, I will just say here that the prototype was successful enough to make people see the real possibilities of the videodisc-based system. The first demonstration of the prototype was in November 1980 to 65 physicians in a back room of the Miami Convention Hall where the American Heart Association was holding its Annual Assembly. Those in attendance showed enthusiasm for the project, provided we could manage to teach *all* the CPR skills.

The American Heart Association's Emergency Cardiac Care Subcommittee saw the potential in the system; however, it said that to be really effective as a training tool, the manikin would have to respond not only to compressions and ventilations but also to a whole range of techniques that are simple for a teacher to evaluate but had never before been simulated or evaluated by a computer.

Meeting this challenge would demand real sophistication. The flow of CPR requires first shaking the victim to see if he or she can be awakened, calling out for help, rolling the victim on his or her back if necessary, then getting the victim's airway open, and then looking, listening, and feeling for spontaneous breathing. The manikin would have to be able to tell whether the student was doing all these things. This offered more challenges in the use of sensors and in writing complex software than I had planned. But the members of the Emergency Cardiac Care Committee, especially Drs. William Montgomery and William F. Kaye, set the goals. As a result of their demands and their efforts in reviewing my drafts of scripts for the videodisc, the full system is much better and more comprehensive than it would otherwise have been.

Now let's take a look at what was required to develop the full system.

Help with Equipment

Finding the right video equipment for the project was difficult. No video-tape recorder could achieve the nearly instantaneous response to a student's actions, as measured by sensors in the manikin, that was essential to the success of the coaching loop. Video-tape recorders also lack the ability to provide freeze frames of high quality. Even a home optical videodisc player would have required several seconds to react to the student's actions.

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We approached a number of companies about videodiscs with greater capabilities. Few would talk to us. Only Sony was willing to cooperate in the project. Sony offered both technical and financial support. Ted Sato, Sony's chief videodisc engineer in the United States, and Dan Harris, manager of new-product development for Sony Video Products, were invaluable in supplying videodisc players, videodisc pressing, video monitors, and assistance in putting the first two sensors in the manikin. Even more important, Sato and Harris provided the kind of psychological support that difficult, innovative projects need even more than money and equipment.

The Sony videodisc player, an industrial model LDP-1000, has its own built-in microprocessor for very fast access to video frames. The LDP-1000 and a videodisc are visible in photo 1. The LDP-1000 is a laser optical videodisc whose advanced features can give the student almost instant feedback. The machine also has a connector and a switch on the back to shift control to an external processor.

Laerdal Medical Corporation also generously helped the project by supplying some of its Resusci-Annie teaching manikins.

Because work on the entire system had to proceed in parallel, the people responsible for giving computer life to the manikins—Jerry Poplin and Bob Soltysik—developed a box to simulate the manikin to the computer and a box to simulate the computer to the manikin.

Figure 2 shows how complex the manikins, both adult and infant, became after the Emergency Cardiac Care Committee broadened our goals. Photo 2 provides a peek inside the infant manikin. Poplin and Soltysik spent late nights performing difficult surgery to equip the manikins as needed. Some of the sensors came from burglar-alarm catalogs, and others, like the airway that blocks on computer command, were sheer invention.

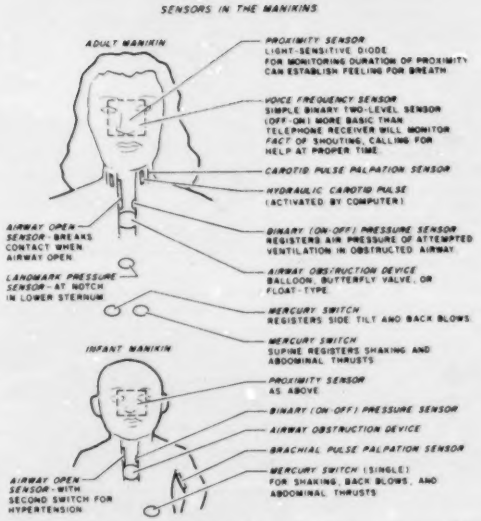

SENSORS IN THE MANIKINS
ADULT MANIKIN
PROXIMITY SENSOR
LIGHT-SENSITIVE DIODE FOR MONITORING DURATION OF PROXIMITY CAN ESTABLISH FEELING FOR BREATH
VOICE FREQUENCY SENSOR
SIMPLE BINARY TWO-LEVEL SENSOR (OFF-ON) MORE BASIC THAN TELEPHONE RECEIVER WILL MONITOR FACT OF SHOUTING, CALLING FOR HELP AT PROPER TIME
CAROTID PULSE PALPATION SENSOR
HYDRAULIC CAROTID PULSE (ACTIVATED BY COMPUTER)
AIRWAY OPEN SENSOR - BREAKS CONTACT WHEN AIRWAY OPEN
BINARY (ON-OFF) PRESSURE SENSOR REGISTERS AIR PRESSURE OF ATTEMPTED VENTILATION IN OBSTRUCTED AIRWAY
LANDMARK PRESSURE SENSOR - AT NOTCH IN LOWER STERNUM
AIRWAY OBSTRUCTION DEVICE BALLOON, BUTTERFLY VALVE, OR FLOAT-TYPE
MERCURY SWITCH REGISTERS SIDE TILT AND BACK BLOWS
MERCURY SWITCH SUPINE REGISTERS SHAKING AND ABDOMINAL THRUSTS
INFANT MANIKIN
PROXIMITY SENSOR AS ABOVE
BINARY (ON-OFF) PRESSURE SENSOR
AIRWAY OBSTRUCTION DEVICE
BRACHIAL PULSE PALPATION SENSOR
MERCURY SWITCH (SINGLE) FOR SHAKING, BACK BLOWS, AND ABDOMINAL THRUSTS
AIRWAY OPEN SENSOR - WITH SECOND SWITCH FOR HYPERTENSION

Figure 2: *The placement and types of sensors in the adult and infant training manikins.*

Photo 2: *A peek inside the infant training manikin. Trainees never see the complex of sensors exposed here. (Photo by Jerry Poplin.)*

The Script

As noted earlier, I thought that the

single greatest challenge in this project was creating a script that could serve the needs of medical experts, video producers, and computer programmers. This unusual script wasn't really a flow chart, although we did sometimes have to make flow charts and then convert them to scripting. The script wasn't a storyboard, but it did have to do the work of one. The script wasn't a simple rendering of content either.

It took five drafts, each in excess of 100 pages, to achieve a workable script. Drs. Montgomery and Kaye contributed greatly by reviewing each of these drafts.

Part of the challenge of writing the script was in developing a sense of what various interactions would look and feel like while the videodisc was being produced, three to six months before much of the programming would begin. It is much to the credit of Jane Sallis and Associates in Dallas, the producer of the videodisc, and Gay Hampton, the production assistant, that the final shooting script resulted in a full and effective use of the random-access videodisc and audio-tape systems. The text box below shows a small excerpt from the script.

Software

We were fortunate to have two excellent programmers working on the CPR project: Bob Sander-Cederlof and Mike Laumer. Bob is the president of S/C Software and author of S/C Assembler II and S/C Macro, bestselling assemblers for the Apple. Mike has written Flash!, what I understand is one of the best compilers for the Apple. Together they produced some 900 pages of assembly-language programming and a couple of Applesoft BASIC routines.

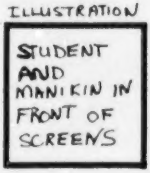
It was the software that brought the 700 video branches to life. (On this, Mike had some assistance from Bobby Deen, an Apple club member who was still a high school student.)

To say the least, the programming task was demanding. The easy part was the 150 pages of text for quizzes and answers. The programmers had to make the videodisc operate in response to light-pen choices with "any time" interrupts. There were also interrupts for the 20 analog and digital systems in the manikin.

By far the most difficult parts of the software were the algorithms that governed the evaluation of hands-on performance by the student. The problem was to read the input array reflecting the student's performance and (1) judge whether the performance took too little or too much time and (2) determine whether each part of the performance occurred in the proper sequence. One or the other of these two parameters alone would have been easier to manage. Together they posed difficulties. Based on performance, the software has to display high-resolution graphics and complement these with video demonstrations and explanations of how to im-

The Script for the Interactive Training System

TV Monitor	Computer Monitor	Script
ILLUSTRATION MATCH DRAWING TO SLIDE	BLANK	*COMPY (SO) V/O: All right. . . . In the position your friend is lying in, the muscles of the jaw relax and the base of the tongue falls back blocking the airway, which makes it difficult, if not impossible, for air to get through to his lungs. . . . Let me show you what I mean. . . .* *(Video screen goes to next illustration, computer screen is blank)*
ILLUSTRATION BENT AIRWAY (MATCH WITH PREVIOUS ILLUSTRATION)	BLANK	*COMPY (SO) V/O: See how the flow of the air to the lungs is being blocked?* *(Video screen goes to next illustration, computer screen is blank)*

TV Monitor	Computer Monitor	Script
ILLUSTRATION 		COMPY (SO) V/O: *So what you'll need to do is open that airway by tilting his head back. . . . This pulls the base of the tongue away from the back of the throat and opens the airway. . . . We'll show you two ways to do that, and then we'll want you to try them on the manikin.* *(Video screen goes to next illustration, computer screen goes to "Touch this spot. . . ." display)*
ILLUSTRATION 		COMPY (SO) V/O: *You can perform CPR on either side of a victim, but for teaching purposes, we'll always have the rescuer on the left side of the manikin. Now kneel down like this beside the manikin and make sure you can see the screen. We'll wait, and when you're ready to begin, touch the computer screen with the light pen.* *(When the computer screen is touched, video screen goes to illustration and computer screen is blank. If no response is monitored within 20 seconds, program reroutes to* HAVE YOU TRIED THAT YET? BRANCH — *Generic/Compy with video screen holding image of student in front of screens)*
ILLUSTRATION 		COMPY (SO) V/O: *Good. . . . Okay, now, the first method for opening the airway is the head-tilt/chin-lift. Notice that one hand is tilting the head back by pressing on the victim's forehead, while the other hand, using three fingers, lifts up on the nearest side of the chin. The lower lip may also need to be held open with the thumb.* *(Video screen goes to matched slide, computer screen is blank)*
SLIDE 		COMPY (SO) V/O: *Here's how that would look in real life. . . . Now we'd like you to try opening the airway on the manikin using this head-tilt/chin-lift method. When you perform on the manikin, you won't need to touch the computer screen to let us know when you've begun, because we'll be able to sense this from the manikin. So go ahead and try it now.* *(Computer program monitors airway sensor in manikin. If airway is not open within 20 seconds, program routes to* HAVE YOU TRIED THAT YET? BRANCH — *Customized/Compy. If the airway is open within 20 seconds, the program proceeds to the* SUCCESSFUL BRANCH*)* HAVE YOU TRIED THAT YET? BRANCH — *Customized/Compy* *(Video screen holds image and computer screen goes to yes/no display)*

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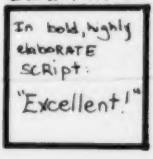
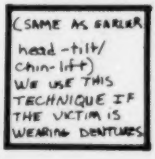
TV Monitor	Computer Monitor	Script
		COMPY (SO) V/O: Did you try it? If you did, answer yes on my screen. If you didn't, answer no. (Depending upon response, program advances to NO BRANCH or YES BRANCH) (NO BRANCH) (Video screen holds image of head-tilt/chin-lift, computer screen goes blank)
		COMPY (SO) V/O: Well, don't be bashful. Please go ahead and try opening the airway. This unconscious victim needs air to breath. (Program continues to return to this response if no action is indicated) (YES BRANCH) (Video screen holds image of head-tilt/chin-lift, computer screen goes blank)
		COMPY (SO) V/O: Well maybe you need to tilt the head back more, and lift up on the chin a little more forcefully. Please don't be hesitant—we want the airway wide open so that this person can breathe. . . . Once you've got it right, we'll proceed—Now, go ahead and try it again. Program monitors performance and proceeds to appropriate branch. If two "Yes" answers entered in a row, program reroutes to LACK OF SUCCESS BRANCH—Generic/Compy. When airway opens, program proceeds to SUCCESSFUL BRANCH)
ILLUSTRATION 		(SUCCESSFUL BRANCH) (Video screen holds image, but adds TV key, computer screen goes blank)
		COMPY (SO) V/O: Excellent . . . And if the victim has dentures, this is the method to use to hold them into place. If rescue breathing is needed, the airtight seal is easier to perform when dentures are in place. But, if dentures cannot be managed in place, remove them. (Video screen goes to illustration, computer screen is blank) Listing 1 shows the programming that brought much of this excerpt to the video screens.

8

The Interpretive Language Used to Program the CPR System

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The interpretive language developed for the CPR course contains over 80 different operations that make possible the programming of the various hardware elements of the system (light pen, Apple video display, videodisc, audio tape, and manikins). The language is similar to assembly language, with the familiar op-code-argument structure known to assembly-language programmers. About half of the instructions provide the computational and logic abilities of a 16-bit processor, while the other half is dedicated to the special hardware elements of the system.

A powerful sublanguage exists for displaying text and low- and high-resolution graphics on the Apple video screen and for building tables for the light pen commands to work from. The tables for the pen command contain the number of entries in the table and each entry contains the x, y, start and stop coordinates for an active region and an invert region. When the pen command executes any detection of the light pen in an active region of a menu, selection will cause the text in the invert region to be highlighted (black text on a white background) to indicate the current selection, and when the pen moves on to another field the previous field is changed back to normal and the new field is highlighted. Touching the ring on the pen to make a menu selection will return a number indicating the table index that was highlighted last, and a tone sounds on the Apple speaker as audio feedback.

Listing 1 shows a sample course segment coded in the interpretive language, with comments on the operation to the side. The related segment of the script is included in the text box on page 120.

Listing 1: A program segment written in the interpreter especially developed for the CPR project. The interpreter resembles assembly language in its use of op-codes and arguments.

```
        SHOW        23157           ;show a still frame on the
                                    video disk.
        CHAN        #3              ;select channel number 3 on
                                    audio tape unit.
        PLAYA       5740,5930       ;play a segment of audio
*                                   from cassette player but do
*                                   not wait for completion; in
*                                   case student catches on to
*                                   the instructions and tries
*                                   the airway opening before
*                                   the voice on the tape
*                                   interrupts from the tape.
*                                   Will shut it off at the proper
*                                   tape address position.
        MENU        A               ;show a menu to student on
                                    the Apple video screen.
CHK     TIMEOUT     30,ERR          ;JUMP to ERR if 30 second
*                                   limit expires and airway still
*                                   not opened.
        WAITAIRWAY                  ;wait for student to open the
                                    manikin airway.
        JUMP        GOOD            ;branch to good performance if airway opened.
ERR     LIST        B,PENTABLE      ;show a menu for student.
        PLAYA       5940,6060       ;"have you tried that yet?"
```

prove performance. Figure 3 is a flow chart of the part of the program that teaches external chest compression.

In the text box on page 126, Mike Laumer gives some insights into how the programming was done. Listing 1 is a sample of some code that Mike wrote in the interpretive language developed for the CPR project.

The Light Pen

There is a big difference between using a light pen to simplify a few types of input and using a light pen as the only input under user control. In our system, the light pen had to do almost everything that a keyboard can but without the keyboard's complexity.

We organized the use of the light pen around a menu of nine choices. The student would choose one of the nine items by pointing the light pen at it and, when the block around the item lights up, touching the place between the light pen's two metal rings. The nine choices, as shown in photo 3, include searching a subject index, a vocabulary check, reviewing the last 15 seconds of instruction, stepping through frame by frame, practicing on the manikin, taking a break, resuming the program after a break, requesting a quiz on material that the student thinks he or she knows, and calling a live person for assistance.

Since it was vital to give students the sense of being in control, we wanted the menu to be available always. We decided that two monitors were necessary and would add to the system's capability. One would always be available to take input from the student and to display output from the computer. The other would constantly display information from the videodisc. At times, we discovered, the two monitors could work together as a highly sophisticated instructional tool. Furthermore, the cost of the second monitor was a small part of the cost of the whole CPR system.

If at any point in the instruction the student gets bored rehashing, say, the anatomy of the heart, the student can switch to "I know this—Quiz me," or to "I want to try the manikin." Such freedom keeps students interested.

To provide for alphabetic input from the students, we provided a "word template" system that provides a listing of the alphabet and allows the student to spell out a word by touching characters in the list. Photo 4 shows the template in use. The software here can handle most misspellings of the words intended. Rather than insisting on exact spellings, the software checks to see if key letters are present in the correct order. If the student is trying to spell "pulse," the software will understand so long as the student enters the letters "PLS" in that order, regardless of the letters that come before, after, or in between.

The light pen provides access to several different levels of explanation of the key vocabulary words. Each level may involve printed and spoken explanations and labeled illustrations. The first definition provided is short and simple, letting the student quickly check the correctness of his or her understanding of the term. The student can always use the light pen to enter "M" for "More" to get a deeper level of explanation. Photo 5 shows a frame with a basic explanation of CPR.

Students also use the light pen during quizzes, as shown in photo 6. Providing different levels of explanation on demand helps to implement the "mosaic" concept of learning, as opposed to the traditional step-by-step, same-for-everyone, linear concept. The system meets the needs of each student. People who want more thorough definitions can always get them. People who just want to learn enough to perform CPR need not go to such lengths.

One benefit of the mosaic approach is that a single nucleus program can satisfy several different levels of learning needs. This helps a great deal in amortizing development costs.

```
        PEN             PENTABLE,SELECTCODE     ;wait for student selection.
        GOTO            SELECTCODE,YES,NO
YES     PLAYA           5040,6060               ;"well, will you please try
                                                it . . ."
        JUMP            CHK                     ;go monitor performance
                                                again.
NO      PLAYA           6100,6180               ;"Well, don't be
                                                bashful . . ."
        JUMP            CHK                     ;monitor performance again.
GOOD    . . .                                   ;continue with course.
        . . .
        . . .
SELECTCODE      BS 1                            ;reserve 1 byte for pen
                                                code.
*
*       MENU DATA SELECTION
*
*       MENU FOR STUDENT INSTRUCTION
*
A       BEGINMENU                               ;start menu A.
        HOME                                    ;clear the screen.
        VTAB 10                                 ;goto line 10.
        HTAB 1                                  ;goto column 1.
        TEXT "PLEASE OPEN THE AIRWAY ON THE MANIKIN"
        VTAB 12                                 ;goto line 12.
        HTAB 1                                  ;goto column 1.
        TEXT "WE'LL CONTINUE WHEN YOU OPEN IT."
        ENDMENU                                 ;end of menu A.
*
*       MENU FOR HAVE YOU TRIED THAT YET?
*
B       BEGINMENU                               ;start menu B.
        HOME                                    ;clear the screen.
        VTAB 10                                 ;goto line 10.
        HTAB 5                                  ;goto column 5.
        TEXT "HAVE YOU TRIED THAT YET?"
        VTAB 12                                 ;goto line 12.
        HTAB 15                                 ;goto line 15.
        BEGINFIELD                              ;start a light pen selection
                                                field.
        TEXT "YES"                              ;text for pen selection.
        ENDFIELD                                ;end a light pen field.
        VTAB 14                                 ;goto line 14.
        HTAB 15                                 ;goto column 15.
        BEGINFIELD                              ;start second light pen field.
        TEXT "NO"                               ;text for pen selection.
        ENDFIELD                                ;end of second light pen
                                                selection.
        ENDMENU                                 ;end of menu.
```

10

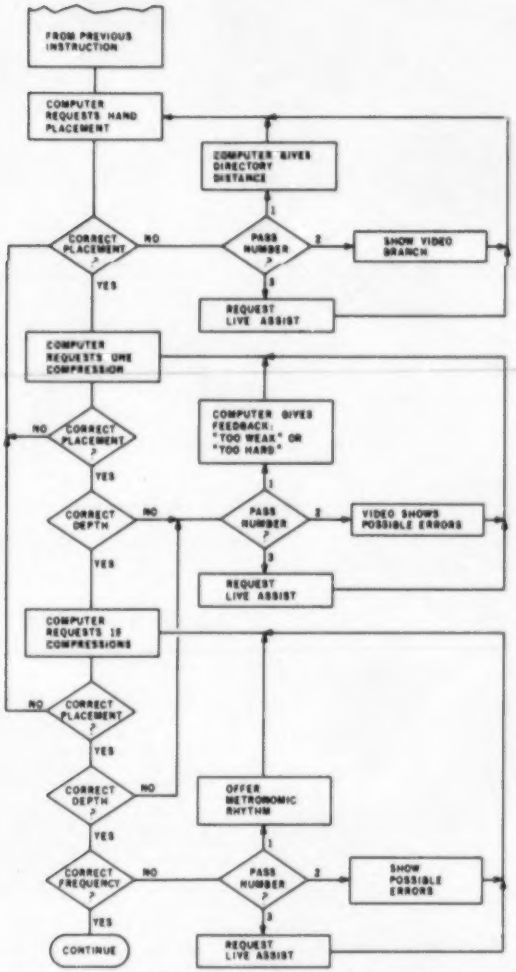


Figure 3: *An early flow chart of the part of the CPR program that teaches external chest compression.*

11

Photo 3: The main menu of the CPR system. Students select an item by using a light pen. (Photo by Bob Luisman.)

Photo 4: The CPR system's word template in use. The student is using a light pen to choose a letter. The letter will next appear on the line above the listing of the alphabet. (Photo by Bob Luisman.)

Photo 5: A video frame explaining CPR (cardiopulmonary resuscitation). The student can get a more thorough explanation on request.

6a

Photo 6: A student using a light pen to enter judgment. In photos 6a and 6b the computer screen displays a list of techniques out of order and the student indicates the next one in the order, which, if correct, will appear above the dotted line. The computer then accesses the videodisc to present the appropriate next segment on the video screen while the list of techniques remains visible on the computer screen (6c). In photo 6d the student makes another selection.

6b

Random-Access Audio

In order to keep up with the videodisc, a random-access audio system would have to be fast indeed. I reasoned that 1/30 of a second would be fast enough on stereo audio tape, and that three usable channels could give us three times the speed of access. To build the random-access sound machine, I commissioned Bob Howard and Dave Weisbrod of BCD Electronics in Oklahoma City, Oklahoma. They were the logical choices because they had already developed a successful frame-accurate video-tape interface card for the Apple II.

There was a certain irony in developing random-access audio at all. Audio technology had preceded video, but it was video technology that first achieved random access. Now we were going back to give the older audio technology one of the fruits of the newer video technology.

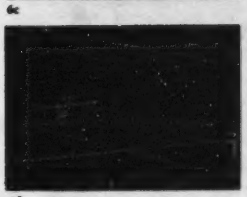
How It Worked Out

Pending final validation results, the system will be used to train from one to four people at a time in the techniques of CPR, with no assistance from a human instructor. If more than one person takes part at a time, the system evaluates each individually. The system also serves as an effective and rapid recertification tool for persons who have previously completed a course in CPR. If the system is used two hours a day, as many as 1700 persons who completed their previous courses six months ago may be recertified in one year.

The flexibility of mosaic courses makes it difficult to say how long the course should take to train any one novice, but the range seems to be from one to five hours, depending on prior medical knowledge, with three hours about average for completing the entire course. When the system is training four people at a time, the expected duration is about four hours; for a recertification after six months, about half an hour; for a recertification after one year, about an hour.

Our early tests show that we accomplished what we set out to do. The CPR student never sees an instructor or a keyboard but is taught CPR skills and is certified more quickly *and* with higher standards than a live instructor can achieve. By the time this article appears, our final

6c



6d

7a

Photo 7: *The system in use. Photo 7a shows the author, in the role of a student, performing chest compressions on the manikin. In 7b the doctor, seen on the video screen, comments on the student's performance and explains the graphed evaluation shown on the computer screen. The student then goes on to perform a ventilation (7c) and "interacts" with an on-screen rescuer in simulated two-person CPR (7d).*

7c

7d

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validation of these results should be complete.

One of the reasons for the system's success becomes apparent only to someone who watches the system in use. Reacting to data supplied by the sensors in the manikin, the system gives far more precise and immediate coaching about the student's position and the depth and rhythm of compression than any human instructor could provide (see photo 7). An individual human instructor can't get inside the manikin the way technology has. An individual human instructor can't always be ready with exactly the right word of guidance or the most apt graphic illustration. But the system is always ready.

The videodisc's large storage capacity and high-speed random-access capability made the system possible, but the technology only presented an opportunity. Human ingenuity had to seize that opportunity. Our success was in bringing together the talents of cooperating physicians, programmers, engineers, and video experts to exploit videodisc technology. It is as if videodisc technology and the computer distilled the expertise of all those people into one small, self-sufficient, and convenient package for optimal presentation to a wide range of individuals. From our results it should be apparent that videodisc technology presents a real opportunity for concentrating expertise and imparting skills in many other fields as well. ■

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